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STUDY OF THE DATA PROVIDED BY A BABY-CLINIC IN A LARGE MANUFACTURING TOWN

BY
MARY NOEL KARN
AND
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WITH FORTY-EIGHT DIAGRAMS IN TEXT AND TWO CHARTS
DRAWN BY IDA McLEARN

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STUDY OF THE DATA PROVIDED BY A BABY-CLINIC IN A LARGE MANUFACTURING TOWN

1. Introduction.

The object of the present study is twofold, namely, to consider the relationships which flow from the data now scheduled, and to suggest on the basis of these relationships what improvements seem desirable in collecting material bearing on infant welfare.

The material we have to deal with consists of data from a baby-clinic in a large north-country manufacturing town, and we have every reason to believe that the observations made were as careful and the supervision was as efficient as are likely to be the case in any similar clinic in this country.

The categories adopted and the manner of applying them were not selected by the members of the Eugenics Laboratory. The function of that Laboratory has been merely to analyse the returns. The Laboratory is solely responsible for the conclusions drawn from the returns; but the returns being what they are it is difficult to see that any other conclusions could be drawn from them. The general problem that we have before us is: What factors are there in heredity or environment which influence the general health of our babies? To that problem various medical authorities have given answers usually emphasising one or other factor as of primary importance. In the opinion of some it is the feeding of the baby, in the opinion of others the clothing of the baby; still others place in the forerank, the cleanliness of the baby, or the cleanliness of the home, or the crowding of the home, or the economic condition of the home, or the employment of the mother, or the habits of one or both parents, or the prenatal or postnatal health of the mother, or a variety of other factors ranging from want of fresh air to use of baby pacifiers.

To the layman who has listened to fairly eager controversy between the medical supporters of one or other view, and has pressed for the ultimate grounds of faith, but scanty statistical evidence has been provided; the controversialists have invariably taken refuge in conviction, deduced apparently by some instinctive process from observational experience. The supporters of clothing, of feeding, or of the evil of comforters have never statistically tested either the efficiency of their own or the inadequacy of their colleagues' theories. They knew from an experience, which it was clear to them the layman could not possess, that their view was a correct one, but they did not recognise that this must invalidate a far wider experience than their own, namely, that of some twenty or thirty of their colleagues who had each come to a different judgment as to the primary factor of infant welfare.

In the present case if the conclusions drawn from our data do not fit the special theory of any individual authority, we shall be told that our material is without value, that it has been carelessly and inefficiently collected. That charge does not concern us; it is a charge against the medical authorities who organised the clinic, and supervised the collection of the material. And to those who make it the authorities in question can well reply: What is the *numerical* experience, what exactly are the data by which you support your own views on infant welfare? Let us have *your* material on the table, and see the process by which you have reached your conclusions. If your material—your experience—as we suspect, is mere impressionism, incapable of numerical statement, and our material is worthless, then may we not at least conclude that nothing at present is known about the factors of infant welfare, nor indeed will be known until the whole subject can be treated without impressionism, without prejudgments, and with determination to get really *accurate* data and abide by the results that flow from them, even if they conflict with our most cherished opinions?

To those who have spent many weary months over this material it appears neither superlatively good nor, on the other hand, superlatively bad. It is just what you might anticipate it would be, after the first enthusiasm of promotion has died down, when a big scheme is carried out largely by voluntary and only partially trained 'field-workers,' who lack the intense earnestness of real scientific minds. Yet on the whole the results are in good accordance with the more weighty material we hope shortly to publish on infant welfare as investigated under the control of the local medical officers.

2. SCALES SELECTED.

(i) In order to represent graphically the results reached and to obtain at least approximations to the association of the various factors involved, we have selected for our broad-category distributions a normal (Laplace-Gaussian) scale of frequency. It will be adequate to illustrate such scales in the following cases:

(*a*) Distribution of Health of Male Babies at one year.
(*b*) ,, ,, ,, Female ,, ,,
(*c*) ,, ,, ,, Mothers of Male Babies.
(*d*) ,, ,, ,, ,, Female ,,
(*e*) Distribution of Clothing of Baby.

In (*a*) and (*b*) the categories used by the doctors concerned were, for health at twelve months, Very Good, Good, Satisfactory, Well, Thriving, Fair, Unsatisfactory, Poor, Dead. We settled after some consideration to divide into six classes and in actual working put the first and second of these together.

TABLE I.

Health Class	Health at 12 months	Male Babies				Health Class	Health at 12 months	Female Babies			
		Number		Average weight in lbs. at 11—14 weeks				Number		Average weight in lbs. at 11—14 weeks	
I	Very Good ...	40	40	12·39	12·39	I	Very Good ...	20	20	11·47	11·47
II	Good	119	218	12·24	12·11	II	Satisfactory ...	85	186	11·19	10·91
	Satisfactory ...	99		11·96			Good	101		10·67	
III	Well	224	298	11·27	11·21	III	Thriving ...	77	316	11·08	10·74
	Thriving ...	74		11·04			Well	239		10·64	
IV	Fair	100	100	10·85	10·85	IV	Fair	57	57	10·21	10·21
V	Unsatisfactory*	71	139	10·99	10·85	V	Unsatisfactory*	54	112	9·91	9·51
	Poor†	68		10·72			Poor†	58		9·14	
VI	Dead	132	132	9·11	9·11	VI	Dead	142	142	9·21	9·21

* 'Not good,' 'not very good' and 'unsatisfactory.'

† 'Poor' and 'very poor.'

It will be seen that the order of classification is justified on the whole very well by the table of weights at 11—14 weeks*. The doctors evidently used 'fair' as something between 'well' and 'poor,' and 'middling' would correspond very aptly to this middle state of 'fair.' It is, perhaps, curious that 'thriving' or 'well' was distinctly a lower category than 'satisfactory' or 'good'; these terms correspond to a big middle group of what may, perhaps, be represented as 'normal' health. We made therefore the following classes of baby's health, using a somewhat different nomenclature: I, Very Satisfactory; II, Satisfactory; III, Normal; IV, Indifferent; V, Unsatisfactory; VI, Dead.

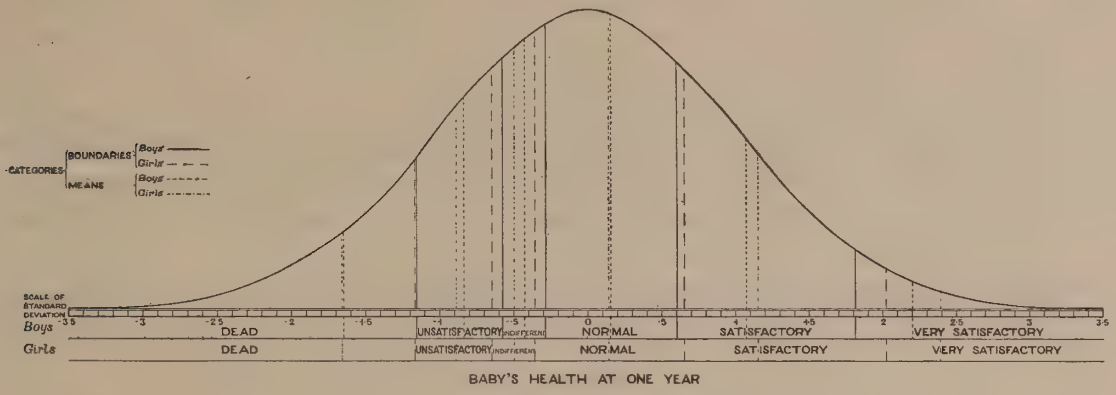

DIAGRAM I.

The Normal scale is given in Diagram I for Boys and Girls. It will be seen that there is very little real difference between boys and girls as far as this scale is concerned. There is, of course, some difference in the variability of health between the sexes. If σ_b, σ_g be the standard deviations in male and female babies respectively, then the range of normal health in boys would be $\cdot 8933\,\sigma_b$ and in girls $1\cdot 0116\,\sigma_g$, or if the medical judgment had an identical range of normal health for boys and girls, then it would follow that boys are more variable in health than girls. We cannot, however, be certain that this is the case, and must content ourselves with the conclusion that no very great differences exist between the health scales for male and female babies.

TABLE II.

Health Class	Health at 12 months	Weight at 20—24 weeks				Weight at 49—55 weeks			
		Boys		Girls		Boys		Girls	
		no.	lbs.	no.	lbs.	no.	lbs.	no.	lbs.
I	Very good	37	16·01	8	14·72	9	21·80	13	19·39
II	Satisfactory and Good ...	202	14·58	174	13·76	148	19·87	123	18·01
III	Well and Thriving	336	14·24	296	13·30	235	19·42	176	17·83
IV	Fair	95	13·40	51	12·41	74	17·52	56	15·54
V	Unsatisfactory and Poor ...	139	12·54	89	11·58	105	16·59	94	14·78
VI	Dead	78	12·49	78	11·90	3	12·47	0	—

---

* Similar tables have been worked out for the weights at 20—24 weeks and 49—55 weeks and they confirm our classification of the categories.

The constants of the scale are as follows:

TABLE III.

Health Class	Boys		Girls	
	Boundaries	Mean	Boundaries	Mean
I	$x/\sigma = +\infty$ to 1·8075	$\bar{x}/\sigma =$ 2·2038	$x/\sigma = +\infty$ to 2·0201	$\bar{x}/\sigma =$ 2·3910
II	„ = 1·8075 to 0·6026	„ = 1·0704	„ = 2·0201 to 0·6538	„ = 1·1506
III	„ = 0·6026 to −0·2907	„ = 0·1459	„ = 0·6538 to −0·3578	„ = 0·1358
IV	„ = −0·2907 to −0·5778	„ = −0·4313	„ = −0·3578 to −0·6500	„ = −0·5003
V	„ = −0·5778 to −1·1567	„ = −0·8434	„ = −0·6500 to −1·1666	„ = −0·8884
VI	„ = −1·1567 to −∞	„ = −1·6520	„ = −1·1666 to −∞	„ = −1·6601

(ii) In Mother's Health (*c*) and (*d*) we have only four main classes, namely, Strong, Good, Fair and Poor. Here again the medical category 'fair' seems to accord with rather under normal health, 'middling' as a descriptive word, something between 'poor' and 'good.' A special class was made for 'anaemic' mothers, certainly without a blood count, and probably because the medical officers in charge or one of them was especially interested in this point. There were less than 4 °/₀ of mothers recorded as anaemic, actually 86 in 2161. In order to test whether anaemia in the mother had any influence on the health of the baby, we considered mother's health in relation to the babies dead and in poor health at a year.

TABLE IV.

Mother's Health Class	Percentage of Babies Dead	Percentage in Poor Health	Combined
Strong and Good ...	12·57	12·16	24·73
Fair	19·29	15·73	35·02
Poor	23·40	12·77	36·17
Anaemic	10·53	14·03	24·56

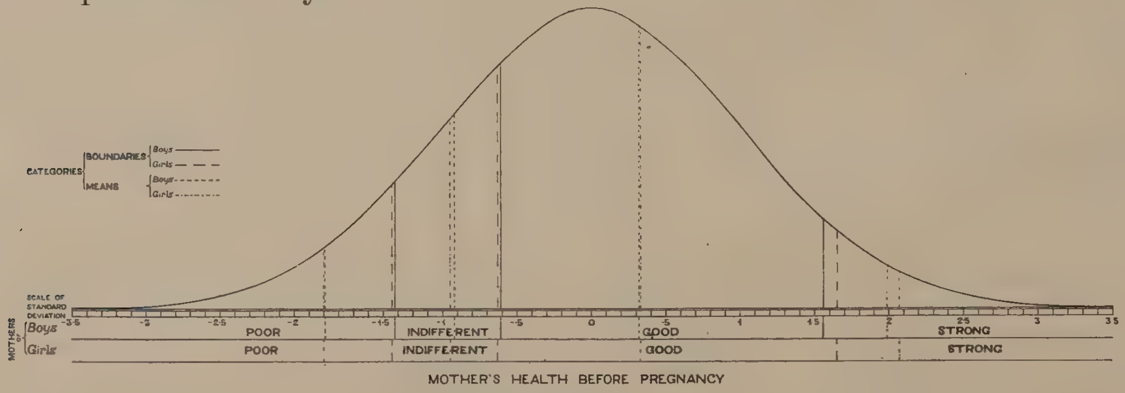

DIAGRAM II.

Now it will be seen from this that the 'anaemic' mothers have a lower infant-mortality and a lower infantile death and delicacy rate than the other classes. Thus it would appear that anaemia as a medical category of maternal health in this case has no influence on the infant's health. We did not, however, feel justified in classing the anaemic mothers with those reported by the same medical judgment to be in strong or good health, and we have accordingly placed this small group in the 'middling' or 'fair' health category.

The scale for mother's health before pregnancy was determined for the mothers of male and the mothers of female babies respectively with the results shown in Diagram II.

TABLE V.

Health Class	Mothers of Boys		Mothers of Girls	
	Boundaries	Mean	Boundaries	Mean
I (Strong) ...	$x/\sigma = +\infty$ to $1{\cdot}5643$	$\bar{x}/\sigma = 1{\cdot}9935$	$x/\sigma = +\infty$ to $1{\cdot}6478$	$\bar{x}/\sigma = 2{\cdot}0652$
II (Good) ...	,, $= 1{\cdot}5643$ to $-0{\cdot}6072$	,, $= 0{\cdot}3204$	,, $= 1{\cdot}6478$ to $-0{\cdot}6328$	,, $= 0{\cdot}3260$
III (Indifferent)	,, $= -0{\cdot}6072$ to $-1{\cdot}3195$	,, $= -0{\cdot}9236$	,, $= -0{\cdot}6328$ to $-1{\cdot}3380$	,, $= -0{\cdot}9455$
IV (Poor) ...	,, $= -1{\cdot}3195$ to $-\infty$	,, $= -1{\cdot}7865$	,, $= -1{\cdot}3380$ to $-\infty$	,, $= -1{\cdot}8020$

Thus the range of good health of the mothers of boys is 2·1715 σ and of the mothers of girls 2·2806 σ. It would thus seem that, this range of health being supposed the same for both sexes, the variability in health of mothers of girls is less than that of the mothers of boys. This is confirmed by the fact that in the case of boys the extreme categories, 'strong' and 'poor,' provide respectively 5·9 °/$_{\circ}$ and 9·4 °/$_{\circ}$ of the mothers, while in the case of girls they only provide 5·0 °/$_{\circ}$ and 9·0 °/$_{\circ}$ of the mothers. The differences are not, however, very wide, and the two scales may be taken as on the whole confirming each other.

(iii) We now come to the question of baby's clothing. The garments are here classed as of wool, flannel, flannelette or cotton makes, and besides these we may have the clothing a mixture of wool with flannel or flannelette or cotton. Apart from the garments provided by the mothers themselves, there were a certain number of babies in clothing provided by the baby-clinic itself. This clothing was presumably that which was considered medically the best, and we have accordingly put this group with the first or wool-clothed infants. The group is, however, small in number, and it is probable that only very poor mothers, or mothers lacking in a certain quality of mind, allowed their infants to be clothed by the baby-clinic itself. It is conceivable that these mothers came from deficient homes and that the inclusion of this group may lower a little—it is too small to lower much—the influence of wool clothing on health*.

---

* The difficulty has occurred in other cases. A large town opened a municipal milk supply and was aghast at finding a higher death rate among the infants using the municipal milk than among the rest of the population of the same class. It closed the milk depot, instead of recognising that it was precisely mothers of delicate infants who would hope for improvement from a better class of milk. Hospitals especially for infants may show a very high rate of mortality, because mothers will not bring their infants and leave them, unless all home treatment has failed. The efficiency of special clothing, special milk, and special infant treatment cannot be tested unless they are applied to a random sample of the general population, or unless the results for the particularly selected group of infants are compared against equally delicate infants without the special provision.

We first arranged our material in the following classes:

I. Wool or Baby-clinic Garments.
II. Wool Vest, Long Sleeves.
III. Wool Vest, Short Sleeves.
IV. Wool and Flannel.
V. Wool with Flannelette or Cotton.
VI. Flannel.
VII. Flannelette.
VIII. Flannelette and Cotton or Cotton only.

In this arrangement of categories we pass from wool to flannel and from flannel to flannelette and cotton.

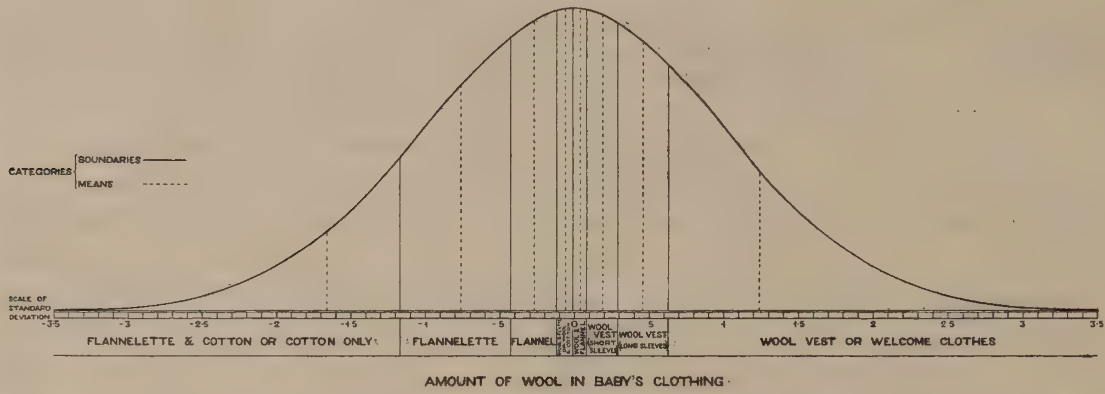

Diagram III.

Diagram III gives the scale of clothing for combined male and female babies.

Table VI.

Clothing Class	Boundaries	Mean
I	$x/\sigma = +\infty$ to $0{\cdot}6298$	$\bar{x}/\sigma = 1{\cdot}2373$
II	„ $= 0{\cdot}6298$ to $0{\cdot}2921$	„ $= 0{\cdot}4565$
III	„ $= 0{\cdot}2921$ to $0{\cdot}0843$	„ $= 0{\cdot}1875$
IV	„ $= 0{\cdot}0843$ to $-0{\cdot}0079$	„ $= 0{\cdot}0382$
V	„ $= -0{\cdot}0079$ to $-0{\cdot}1186$	„ $= -0{\cdot}0632$
VI	„ $= -0{\cdot}1186$ to $-0{\cdot}4269$	„ $= -0{\cdot}2706$
VII	„ $= -0{\cdot}4269$ to $-1{\cdot}1690$	„ $= -0{\cdot}7622$
VIII	„ $= -1{\cdot}1690$ to $-\infty$	„ $= -1{\cdot}6621$

3. Influence of Clothing on Baby's Health.

The following are the percentages of the various types of baby-clothing found in 716 female and 748 male cases, with the weights of the babies at 12·5 weeks*, and in 542 male and 449 female cases with weights at 52 weeks†:

---

* Weights for babies averaged for 11th, 12th, 13th and 14th week visits.

† Weights averaged for 49th, 50th, 51st, 52nd, 53rd, 54th and 55th week visits.

Table VII.

Types of Clothing as described	Boys				Girls			
	Percentage at 12·5 weeks	Weight in lbs. at 12·5 weeks	Percentage at 52 weeks	Weight in lbs. at 52 weeks	Percentage at 12·5 weeks	Weight in lbs. at 12·5 weeks	Percentage at 52 weeks	Weight in lbs. at 52 weeks
Clinic Clothing ...	2·27	12·12	1·29	19·61	1·68	10·72	0·67	18·47
'Wool'	7·89	10·89	13·65	18·33	10·47	10·70	12·25	17·45
'Wool Vest'	16·71	11·53	14·94	18·64	14·94	10·85	13·59	17·75
Wool Vest, Long Sleeves	16·44	11·23	21·78	18·52	19·28	11·07	16·48	17·70
Wool Vest, Short Sleeves	3·48	12·51	7·56	18·86	6·28	11·71	4·68	17·52
Wool and Flannel ...	2·94	10·47	2·21	18·80	5·03	9·25	3·56	19·09
Wool with Flannel or with Cotton ...	4·28	11·00	4·43	17·09	2·37	10·12	5·12	15·38
Flannel	13·64	11·71	12·55	18·95	10·34	9·71	12·03	16·73
Flannelette	16·98	11·15	15·32	19·46	13·55	9·81	25·83	16·50
Cotton	15·37	10·75	6·27	19·12	16·06	10·05	5·79	17·55
Means or Totals ...	100·00	11·26	100·00	18·73	100·00	10·44	100·00	17·17

The numbers dealt with are too small to get any very certain results, especially in some of the categories. But we note that:

(i) Babies using the clinic clothing are over mean weight at 12·5 weeks and at 52 weeks in the case of both sexes.

(ii) 'Wool Vests' appear to be associated with weights above the average in case of both female and male babies at both ages.

(iii) Flannel appears associated with excess weights for boys at both ages, and defective weights for girls at both ages!

(iv) Flannelette and cotton give weights below the mean for both sexes at 12·5 weeks, but give weights considerably above the mean for male babies at a year. Female babies at a year give inconclusive results.

We may get possibly more definite means by dividing into three classes, namely:

'Wool,' embracing our first five categories;

'Flannel,' embracing flannel and mixed materials;

'Cotton,' embracing flannelette and cotton.

Table VIII.

Clothing	Boys				Girls			
	12·5 weeks		52 weeks		12·5 weeks		52 weeks	
	%	lbs.	%	lbs.	%	lbs.	%	lbs.
Wool ...	46·79	11·39 ± ·0894	59·22	18·57 ± ·1105	52·65	11·00 ± ·0710	47·67	17·64 ± ·1179
Flannel ...	20·86	11·39 ± ·1339	19·19	18·51 ± ·1941	17·74	9·63 ± ·1223	20·71	16·80 ± ·1788
Cotton ...	32·35	10·96 ± ·1075	21·59	19·36 ± ·1830	29·61	9·94 ± ·0946	31·62	16·69 ± ·1447
Means ...	—	11·26 ± ·0621	—	18·73 ± ·0866	—	10·44 ± ·0540	—	17·17 ± ·0847

These results indicate a curious sex difference, namely:

(i) For female babies flannel and cotton substances are about equal in value, and both are for both ages inferior to wool.

(ii) For male babies flannel and wool garments are about equal in value; both show better results than cotton for the younger babies, but worse results than cotton for the older babies.

Now we come to the question of how far such an apparently paradoxical result is reliable. There are two ways of examining it:

(*a*) *Effect of Selection.* Many babies drop out of the weight record between the 12·5th and 52nd week. The following tables exhibit this.

TABLE IX.

Nature of Clothing	Boys			Girls		
	12·5 weeks	52 weeks	Percentage left record	12·5 weeks	52 weeks	Percentage left record
Wool ...	350	321	8·3	377	214	43·2
Flannel ...	156	104	33·3	127	93	26·8
Cotton ...	242	117	51·7	212	142	33·0
Totals and Percentages	748	542	27·5	716	449	37·2

It is clear that it is the wool-clad girls who drop out of the record, not the wool-clad boys. It is the cotton and flannel clothed boys who disappear. Do mothers of boys continue to frequent the clinic longer than mothers of girls? This might be due to a maternal prejudice which puts a higher value on the male baby, or to a greater delicacy rate of the male baby affecting the period during which the mother visits the clinic or a combination of these causes. It might even be argued that cotton clothes kill all but the hardiest babies of the male sex, and so those left are heavier than the wool-clad babies! Or, that the more delicate male babies are put into wool and thus the cotton-clad appear heavier at a year. Again, we might argue mothers of good habits use wool, mothers of bad habits use flannel or cotton, and the latter cease to visit the clinic. This might throw light on the matter, were it not for the fact that mothers of good habits who clad their girl babies in wool drop out of the record at a higher rate than mothers of cotton- or flannel-clad girl babies!

TABLE X.

Clothing	Boys			Girls		
	Death Rate	Delicacy Rate	Death and Delicacy Rate	Death Rate	Delicacy Rate	Death and Delicacy Rate
Wool	8·18 °/o	16·11 °/o	24·29 °/o	8·45 °/o	10·99 °/o	19·44 °/o
Flannel	13·48 °/o	17·98 °/o	31·46 °/o	14·56 °/o	17·72 °/o	32·28 °/o
Cotton	13·14 °/o	14·60 °/o	27·74 °/o	10·59 °/o	15·25 °/o	25·84 °/o
Whole Population	10·91 °/o	16·01 °/o	26·92 °/o	10·41 °/o	13·75 °/o	24·16 °/o

Let us now examine these results from the standpoint of the death and delicacy rates. We have the data for 843 male and 749 female babies at 12 months.

Table X seems fairly smooth and definite. We see that for both boys and girls the wool-clad have a death and delicacy rate below the average; that for both girls and boys the cotton-clad have a death and delicacy rate only slightly above the average*; lastly, the flannel-clad babies—which include those, relatively few, clothed in mixtures of wool and flannel—show by far the highest death and delicacy rates.

It is, of course, unwise to interpret an association as a causation, but our data do raise the suspicion that while wool is best, cotton is better than flannel or than mixtures of wool, cotton and flannel. Here 'cotton' includes flannelette.

It will be seen that while our male infantile mortality is only slightly more than the female, the delicacy rate is over two points higher. But the increased delicacy rate of the male babies is so slight that it does not explain why more girls drop out of the record than boys, nor will a death rate of 10 °/。 to 11 °/。 explain why 27 °/。 to 37 °/。 drop out.

The fact now comes to light that we have more babies on the record for health and clothing at 52 weeks than we have for weight and clothing at 12·5 weeks! The falling out is not in mothers attending the clinic, but in weight-recording on the part of the clinic staff. It may be that the mothers with the poorer clad babies object more to the stripping and weighing as the babies grow older, or that the authorities of the clinic place less value on the weights. How the differentiation between weighing male and female wool-clad babies arises we are unable to say. But there is some form of cross-selection going on in the weighings of the clinic which throws grave doubt on any conclusions drawn from the association of weights and clothing.

On account of our ampler data we shall accordingly place greater stress on the relation between clothing and general health than on that between clothing and weight.

(*b*) *Significance of Differences.* The reader will probably have already recognised that the apparent associations are not insignificant. All four correlation ratios—if not very large—are quite significant. Thus we have:

TABLE XI. *Correlation Ratios of Weight on Type of Clothing.*

	Boys	Girls
At 12·5 weeks ...	$\eta = \cdot 1714 \pm \cdot 0329$	$\eta = \cdot 3021 \pm \cdot 0229$
At 52 weeks	$\eta = \cdot 1913 \pm \cdot 0290$	$\eta = \cdot 2794 \pm \cdot 0293$

The following are the correlation coefficients, calculated on the assumption that the scale is normal and arranged according to the relative amounts of wool in the various categories. We did not feel able to place the results for Cotton and Flannelette between the Wool and Flannel results, as this certainly gives a less logical basis for a continuous scale, although to do so would have emphasised the value of r as the dips at the flannel and mixed flannel clothing are quite significant, as the probable errors indicate.

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* In fact the cotton-clad boys have a lower delicacy rate than the wool-clad boys, probably a result of natural selection.

TABLE XII. *Correlation Coefficients of Weight and Clothing.*

	Boys	Girls
At 12·5 weeks ...	$r = +\cdot 0714 \pm \cdot 0245$	$r = +\cdot 1740 \pm \cdot 0244$
At 52 weeks	$r = -\cdot 0724 \pm \cdot 0288$	$r = +\cdot 1114 \pm \cdot 0314$

A comparison of these correlation coefficients with the corresponding correlation ratios emphasises the points we have been considering. All values are significant, but our scale for extent of wool clothing adopted to find the correlation coefficients gives much lower values than those of the correlation ratios; the influence of clothing is not solely due to the amount of wool used. Cotton and flannelette do not merely signify absence of wool; they are, as we have seen, better than flannel or flannel and wool mixed. For male babies at a year old the correlation of weight and amount of wool in clothing has even a small negative value. Whatever it is that differentiates the efficiency of various types of clothing it does not appear to be purely its woollen character.

Can it be that wool clothing—since the correlations are relatively small—is only an index to a factor more important than clothing for infant welfare?

Clothing and Economic Conditions.

(*a*) We can test this first on economic conditions. A good measure of these conditions is the father's wage. We found the wage given in 663 cases where the clothing had been recorded. The mean wage (of course a pre-war wage) was 24·97*s.* ± ·17*s.* and the standard deviation 6·48*s.* The means of each category are as follows:

TABLE XIII.

Character Class of Clothing		No.	Mean Wage of Father and its Probable Error	
I	Wool	152	26·00*s.* ± ·35	25·08*s.* ± ·26*s.*
II		74	23·26*s.* ± ·51	
III		52	24·96*s.* ± ·61	
IV	Wool and Flannel	17	26·02*s.* ± 1·06	25·40*s.* ± ·28*s.*
V	Wool with Flannelette or Cotton	19	22·85*s.* ± 1·00	
VI	Flannel	89	25·83*s.* ± ·46	
VII	Flannelette	169	24·45*s.* ± ·34	24·65*s.* ± ·27*s.*
VIII	Cotton	91	25·02*s.* ± ·46	

It is clear that the effects of random sampling on the small categories may well amount to anything from 1*s.* to 2*s.* and on the larger from 6*d.* to 1*s.*, so that the variations in wage have no significance, and we cannot assert that it is the father's wage which determines baby's clothing.

Actually the correlation* is given by $r = {\cdot}0426 \pm {\cdot}0262$ and is not significant.

The above results were obtained by excluding the class of 'no wage' fathers. If we include these we find:

TABLE XIV. *Percentages of Babies with various types of Clothing.*

	Wool	Flannelette and Cotton	Flannel	Mixtures
General Population ...	42·1 %	38·8 %	13·0 %	6·1 %
Unemployed Fathers ...	42·9 %	36·5 %	11·1 %	9·5 %

It is not unemployment of father which leads to the baby having a cheaper form of clothing. It is conceivable that the baby has better garments owing to a greater use of charitable provision.

(*b*) We next turn to the habits of the mother as exhibited by the home conditions.

The Clothing of Baby and the Home Conditions were given in 532 cases as follows:

TABLE XV.

Home Conditions	Baby's Clothing								
	I	II	III	IV	V	VI	VII	VIII	Totals
Good	78	83	17	14	10	36	41	32	311
Clean, Fair	14	14	5	6	4	9	16	11	79
Dirty, Poor, etc. ...	31	18	3	4	11	16	38	21	142
Totals	123	115	25	24	25	61	95	64	532

Using the triserial η method with class-index correction we find:

$$\text{Correlation} = {\cdot}2542 \pm {\cdot}0274.$$

We can bring this out in broad lines more clearly if we take our previous three groups, thus:

TABLE XVI.

Baby's Clothing	Percentage of Dirty and Poor Homes
Wool	19·77 %
Flannel and Mixtures ...	28·18 %
Cotton and Flannelette ...	37·11 %
All Categories	26·69 %

It would appear from these results that the clothing of baby is rather an index to home conditions and the habits of the parents, than to the economic conditions. Thus the relatively small correlations between clothing and weights may not have anything of the nature of cause and effect, but be simply an index to some more important factor like parental habits, which influences both baby's health and baby's clothing. All we can say is that those authorities who assert an intimate relation between health of baby and its clothing will not find support for their thesis in our data, if we suppose in the first place weight a reasonable measure of the general health of the infant.

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* The value of the correlation ratio $\eta = {\cdot}1537$ after correction for class-index may also be considered insignificant. For now $\eta^2 = {\cdot}0214$ and $\bar{\eta}^2$ for no correlation $= {\cdot}0106$ which is practically a difference within the probable error.

(*c*) We can consider these economic and home conditions from two indirect standpoints.

(i) Father's wage is not always a reliable factor, but we have found in other inquiries that father's health is very closely associated with his wage*. We will therefore inquire whether father's poor health is related to baby's clothing. Our table is:

TABLE XVIII.

Father's Health	Baby's Clothing (♂ + ♀)								
	I	II	III	IV	V	VI	VII	VIII	Totals
Strong	67	33	23	17	15	21	42	36	254
Good	200	47	42	23	30	91	138	107	678
Indifferent ...	19	12	3	6	3	5	10	6	64
Poor	22	14	5	3	5	20	20	11	100
Dead	6	—	—	—	1	2	3	1	13
Totals	314	106	73	49	54	139	213	161	1109

First consider the result in three classes:

TABLE XIX.

Baby's Clothing	Percentage of Fathers with Indifferent or Poor Health
Wool	17·85 ± 1·16
Flannel	18·59 ± 1·69
Cotton	14·97 ± 1·16
All Categories ...	15·97 ± 0·71

* We have directly correlated Father's Wage and Father's Health and find the fourfold table

TABLE XVII.

Father's Wage	Father's Health		Totals
	Strong and Good	Indifferent and Poor	
17*s.* and over	317	45	362
Under 17*s.*	63	31	94
Totals	380	76	456

leading to the value of tetrachoric r $r = {\cdot}4032 \pm {\cdot}0590$.

Thus even with these returns—which are not the most accurately recorded data—there is a very sensible relation between Father's Wage and his Health.

None of the categories are twice their probable error from the mean and these results suggest no association. The correlation was then worked out and gave

$$r = -\cdot 0026 \pm \cdot 0203.$$

The insignificance of r was confirmed by considering the correlation ratio of Father's Health and Baby's Clothing:

$$\text{Uncorrected } \eta^2 = \cdot 0075,$$

$$\text{Mean } \bar{\eta}^2 \text{ for no association} = \cdot 0063.$$

Thus the view is confirmed that economic conditions do not determine the nature of the infant's clothing in our district.

(*d*) (ii) In the same way that Father's Health affects the economic conditions, Mother's Heath may affect the home conditions and be responsible for Baby's Clothing. This is easily determined from the following table:

TABLE XX.

Mother's Health	Baby's Clothing								
	I	II	III	IV	V	VI	VII	VIII	Totals
Strong	27	11	11	3	3	10	29	9	103
Good	341	151	101	46	56	157	261	164	1277
Indifferent ...	98	35	25	15	16	32	74	37	332
Poor	34	27	15	6	8	22	35	16	163
Totals	500	224	152	70	83	221	399	226	1875

Taking first our three broad categories:

TABLE XXI.

Clothing of Baby	Percentage of Mothers with Indifferent or Poor Health
Wool	$26 \cdot 71 \pm 1 \cdot 01$
Flannel	$26 \cdot 47 \pm 1 \cdot 54$
Cotton	$25 \cdot 92 \pm 1 \cdot 18$
All Categories ...	$26 \cdot 40 \pm 0 \cdot 69$

and then looking at the correlation

$$r = \cdot 0129 \pm \cdot 0156$$

and

$$\text{Uncorrected } \eta^2 = \cdot 0071,$$

$$\text{Mean } \bar{\eta}^2 \text{ for no association} = \cdot 0037 \pm \cdot 0032.$$

We conclude that the source of any association between Baby's Clothing and Baby's

Weight is not an indirect effect of any relation between Mother's Health and Baby's Health*. The former is quite unrelated to Baby's Clothing.

We now turn to the main point of this section, the direct relation of clothing to the infant's general health.

We take health at 'first visit' and health at a year.

The following are the tables for male and female babies at first visit:

TABLE XXIV.

Health Category	Male Babies' Clothing								
	I	II	III	IV	V	VI	VII	VIII	Totals
Very Satisfactory ...	16	20	4	1	2	5	9	12	69
Good	144	80	35	14	19	76	107	67	542
Indifferent	31	15	7	4	9	20	24	16	126
Poor	30	13	2	3	4	11	32	17	112
Totals	221	128	48	22	34	112	172	112	849

Health Category	Female Babies' Clothing								
	I	II	III	IV	V	VI	VII	VIII	Totals
Very Satisfactory ...	8	12	6	3	2	1	12	2	46
Good	130	81	42	21	24	48	103	57	506
Indifferent	31	12	8	7	5	17	17	17	114
Poor	20	4	3	5	3	16	17	14	82
Totals	189	109	59	36	34	82	149	90	748

Let us first apply the test of the three broad categories.

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* Curiously enough we have found no correlation of any real importance between Mother's Health either before pregnancy or after confinement, with Home Conditions.

The tables are as follows:

TABLE XXII.

Home Conditions	Mother's Health before Pregnancy				
	Strong	Good	Indifferent	Poor	Totals
Good	21	194	61	30	306
Fair	8	74	19	5	106
Bad	9	119	24	17	169
Totals	38	387	104	52	581

$\eta = \cdot 0922 \pm \cdot 0277, \qquad r = -\cdot 0581 \pm \cdot 0279$

TABLE XXV.

Clothing	Percentage of Babies of Indifferent or Poor Health	
	Boys	Girls
Wool	$24{\cdot}69 \pm 1{\cdot}46$	$21{\cdot}85 \pm 1{\cdot}48$
Flannel	$30{\cdot}35 \pm 2{\cdot}39$	$34{\cdot}87 \pm 2{\cdot}61$
Cotton	$31{\cdot}34 \pm 1{\cdot}86$	$27{\cdot}20 \pm 1{\cdot}94$
All Categories	$28{\cdot}03 \pm 1{\cdot}04$	$26{\cdot}20 \pm 1{\cdot}08$

There is here a difference beween boys and girls. Flannel is worse than cotton for girls and about the same as cotton for boys. In both cases wool is sensibly the best. But the bigness of the probable errors shows that we are not dealing with anything but slight correlations.

We have

TABLE XXVI.

	Correlation Coefficient	Correlation Ratio
Boys	$r = +{\cdot}0454 \pm {\cdot}0231$	$\eta = {\cdot}1830 \pm {\cdot}0224$
Girls	$r = +{\cdot}0896 \pm {\cdot}0245$	$\eta = {\cdot}3148 \pm {\cdot}0222$

It will be clear on examining Table XXIX that the relationship between clothing and health becomes rather more intense with age. The much larger values of η than of r are due to the facts (a) that the flannel and wool mixtures give lower health results than the cotton, and (b) that the group containing the clinic clothing and merely 'wool' gives worse results than those described as 'wool vests with sleeves' and 'wool vests without sleeves.' These effects are persistent for both sexes and both age periods.

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and again

TABLE XXIII.

Home Conditions	Mother's Health after Confinement				
	Strong	Good	Indifferent	Poor	Totals
Good	4	203	60	27	294
Fair	5	72	17	13	107
Bad	5	98	34	21	158
Totals	14	373	111	61	559

$\eta = {\cdot}1123 \pm {\cdot}0282$, $r = +{\cdot}0512 \pm {\cdot}0285$

Neither correlation is of real significance, nor are the correlation ratios when η^2 is compared with $\bar{\eta}^2$.

If the correlation coefficients were of significance, the mother in worse health would have the tidier home before pregnancy and the less tidy home after confinement.

The corresponding tables at a year are:

TABLE XXVII.

Health Category	Male Babies' Clothing								
	I	II	III	IV	V	VI	VII	VIII	Totals
Very Satisfactory ...	2	0	14	0	0	9	6	3	34
Satisfactory	28	37	46	3	5	25	35	21	200
Normal	38	37	59	7	16	41	54	30	282
Indifferent	13	8	14	2	2	12	25	24	100
Unsatisfactory ...	17	17	29	5	10	17	28	12	135
Dead...	10	6	16	6	10	8	18	18	92
Totals	108	105	178	23	43	112	166	108	843

Health Category	Female Babies' Clothing								
	I	II	III	IV	V	VI	VII	VIII	Totals
Very Satisfactory ...	5	3	3	1	1	1	3	0	17
Satisfactory	20	28	48	5	5	20	40	11	177
Normal	47	37	60	18	14	26	59	31	292
Indifferent	11	8	16	2	2	12	21	10	82
Unsatisfactory ...	9	15	15	3	9	16	19	17	103
Dead...	9	7	14	6	2	15	11	14	78
Totals	101	98	156	35	33	90	153	83	749

We try first the three broad categories method and find:

TABLE XXVIII.

Clothing	Percentage of Babies in Unsatisfactory Health or Dead	
	Boys	Girls
Wool...	24·29 ± 1·46	19·44 ± 1·42
Flannel	31·46 ± 2·35	32·28 ± 2·51
Cotton	27·74 ± 1·82	25·84 ± 1·92
All Categories ...	26·92 ± 1·03	24·16 ± 1·06

Again, the probable errors of the percentages are rather large, but we see that in both boys and girls it is the flannel, including mixed wool and flannel, which is associated with bad health. On the other hand, cotton and flannelette are as much better than flannel as wool is better than cotton.

Looked at from the standpoint of correlation we have:

TABLE XXIX.

	Correlation Coefficient	Correlation Ratio[*]	Correlation Coefficient corrected for Mother's Health, Father's Health and Father's Wage[†]
Boys ...	$r = + \cdot 1257 \pm \cdot 0229$	$\eta = \cdot 2110 \pm \cdot 0222$	$r = + \cdot 1227 \pm \cdot 0229$
Girls ...	$r = + \cdot 1202 \pm \cdot 0243$	$\eta = \cdot 2214 \pm \cdot 0234$	$r = + \cdot 1160 \pm \cdot 0243$

It may be of interest to record that the mean square contingency coefficients corrected for class-index correlations are respectively ·1923 and ·1791.

A glance at the lowest figures of Diagrams IV and V shows why η is so much in excess of r. r is calculated on a scale of increasing amount of wool, but this is not the scale of association with health. It is the materials mixed with wool that appear to produce the ill effect on boys, while all flannel appears to have a markedly detrimental effect on girls which it has not on boys.

We conclude generally that while clothing is *not* a very intensive factor in infant welfare, yet wool certainly is the best material. Wool mixtures are to be avoided, being on the whole worse than cotton or flannelette. Flannel pure and simple appears distinctly bad for girls but less so for boys. See Diagrams IV and V. We are not able to explain this difference in its effect on the sexes, but our probable errors suggest that it is really significant.

We must confess to feeling by no means satisfied that the modest association of baby's clothing with baby's health is of a causative nature. We have not been able to trace any more direct relationship to economic conditions or parental habits[†]. But another method of approaching the problem occurred to us, namely, to see what is the relationship of baby's clothing to baby's weight at very early visits. We were able to collect only 300 cases of visits made when the baby was under three weeks of age. But if the association should turn out to be as high at less than three weeks as at a year, it would seem improbable that the clothing could in this short time be responsible in any way for the nature of the weight.

The average of the visit was at 14·1 days and the correlation was found to be

$$r = \cdot 2790 \pm \cdot 0360,$$

with an $\eta = \cdot 4251$! The correlation is therefore *higher*.

The 'flannel' and 'mixtures' dip was still more exaggerated than in either the data for 12·5 weeks or in those for 12 months. See for the latter the two upper figures in Diagrams IV and V, pp. 18, 19. We have then:

Correlation Ratios of Clothing and Weight.

At 14·1 days	Boys and Girls + ·4251	
At 12·5 weeks	Boys + ·1830 Girls + ·3148	+ ·2489
At 52 weeks	Boys − ·2110 Girls + ·2214	+ ·0052

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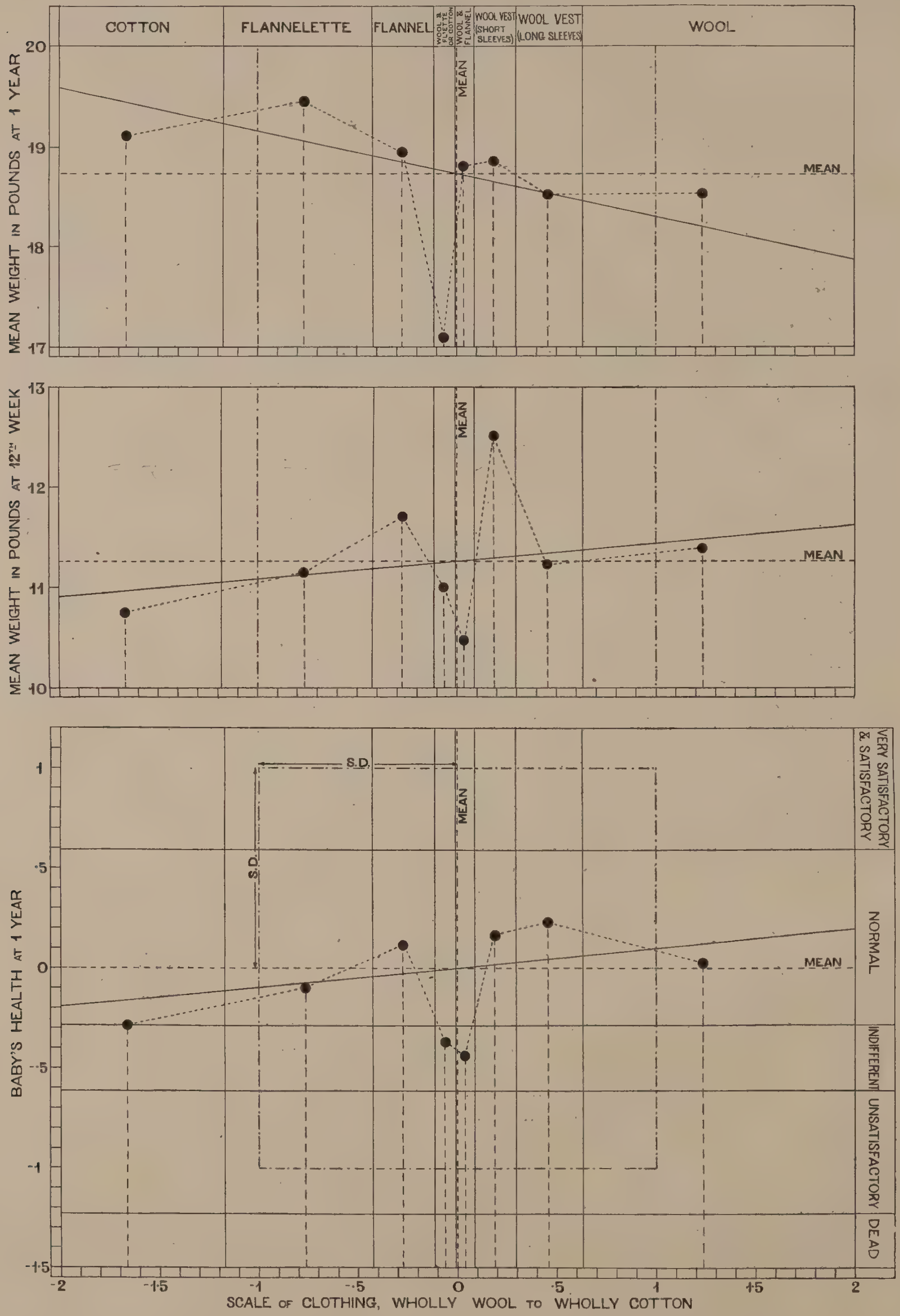
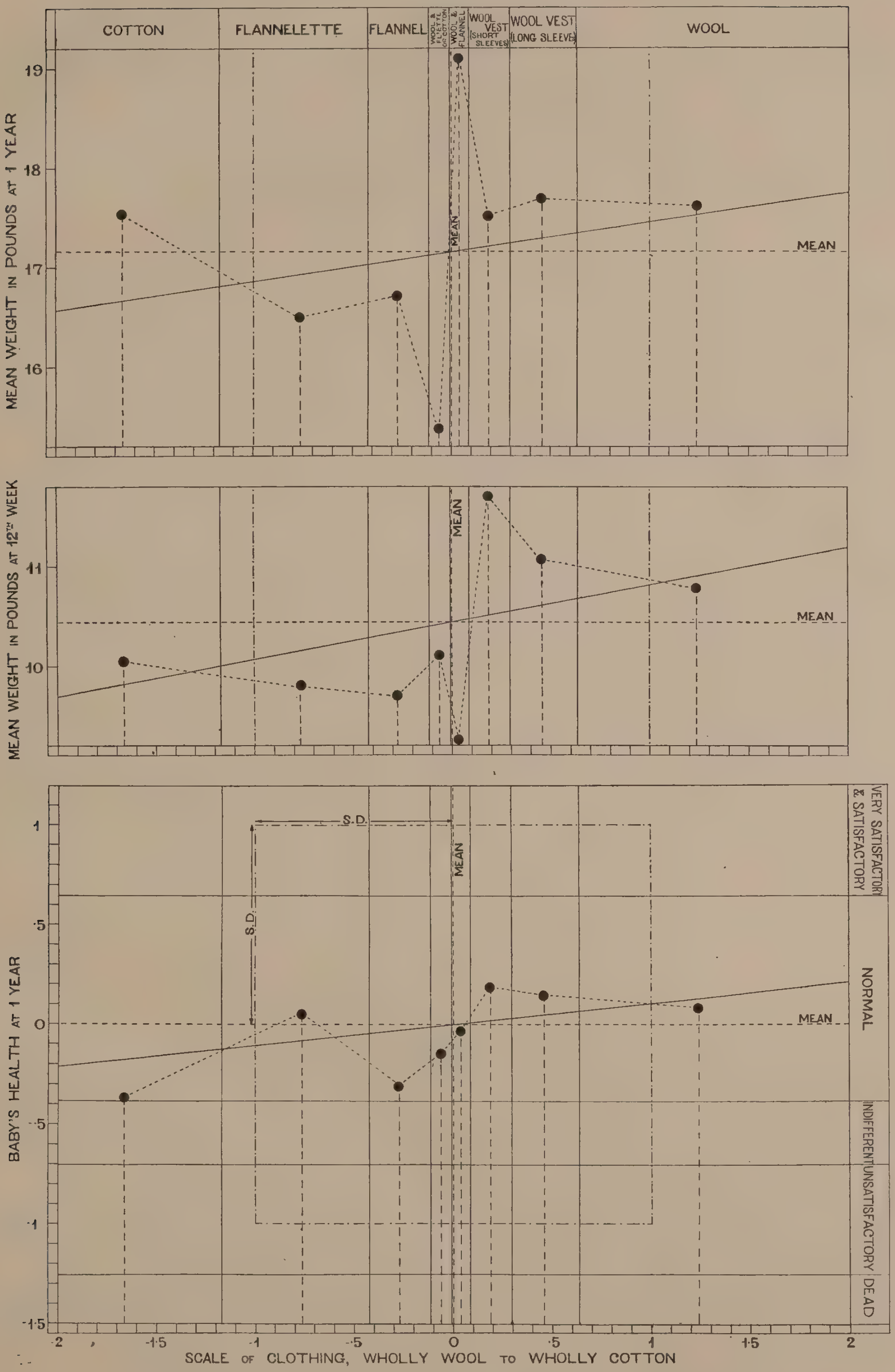
[*] η is taken as the mean of the η both ways.

[†] We give the partial correlation coefficients to indicate that clothing associations cannot be looked upon as indirect effects of parental health or economics.



INFLUENCE OF CLOTHING ON BABY'S HEALTH & WEIGHT-MALE.

DIAGRAM IV. (Rectangle represents the doubled standard deviations.)



INFLUENCE OF CLOTHING ON BABY'S HEALTH & WEIGHT-FEMALE.

DIAGRAM V. (Rectangle represents the doubled standard deviations.)

The relation thus decreases with age, as the diagrams also indicate. It is impossible to believe that in the course of 14 days the effect of flannel on the weight could make itself so markedly felt. We suspect there may be some custom in the district of wrapping delicate babies in flannel. If so, we have no real evidence against 'flannel,' and all we can say is, that wool is somewhat better than cotton or flannelette for young babies, but that clothing is not really a very important factor of baby welfare.

4. INFLUENCE OF FEEDING ON BABY'S HEALTH.

The factor of feeding is held by many authorities to be of very great importance, and much has been written about (*a*) the evil of artificial feeding and (*b*) the relative merits of various methods of treating cow's milk. From the data in possession of the Laboratory bearing on this point we have learnt that the difference of health due to breast and artificial feeding is not great *when the health and habits of the parents are good.* It is the parents of bad health and of bad habits who weight the death and delicacy rates of the artificially fed babies.

Now a very large number of babies are not entirely breast fed up to 12 months, and if we take the health at 12 months as a test of the influence of the feeding we have to consider a variety of combinations of (i) wholly breast feeding, (ii) breast feeding accompanied by part artificial feeding, (iii) wholly artificial feeding, for every length of time. After turning over the problem in a variety of ways, it seemed desirable to form two scales, one of *wholly* breast feeding for different periods, and one of artificial feeding. These are to be independently correlated with health, and we must ascertain to what extent the correlations confirm each other. The following are the categories adopted:

(i) *Scale for Periods of Wholly Breast Feeding.*

Categories	Contents
I	Wholly breast fed 12 or more months
II	,, ,, 9, 10 or 11 ,,
III	,, ,, 6, 7 or 8 ,,
IV	,, ,, 3, 4 or 5 ,,
V	,, ,, less than 3 ,,
VI	No breast feeding at all

(ii) *Scale for Periods of Artificial Feeding.*

We consider feeding for the 12 months only. (*a*) We do not include any period of wholly breast feeding, (*b*) we include all the period of wholly artificial feeding, (*c*) we reckon periods of part breast, part artificial feeding as if the two types each provided a moiety of the period of partial breast feeding.

(*c*) is the most doubtful part of the proceeding, but there was such a variety of cases of combined forms of feeding and so little really definite information about them, that it seemed only possible to adopt a rough procedure*.

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* For example the transition from breast to artificial feeding might take three months, starting with one artificial meal a day ending with one breast feeding at night. It is impossible to evaluate such proportions of breast and artificial feeding more accurately than by the rough method suggested.

Categories	Contents
I	No artificial feeding at all
II	Less than 3 months artificial feeding
III	3, 4 or 5 months of artificial feeding
IV	6, 7 or 8 ,, ,, ,,
V	9, 10 or 11 ,, ,, ,,
VI	The whole 12 months artificial feeding

The main difference of this scale and the previous scale is the allowance we have made for part breast and part artificial feeding. In the first scale we have allowed only for the period during which the baby was wholly breast fed.

Unfortunately the schedule of the welcome association under consideration while giving occasional information as to the state of home and the habits of the mother does not provide like some of our M.O.H. infant material for a reasoned judgment as to the habits of both parents. Further, the data as to the health of both parents are rather slender. We have only been able to form a rough estimate of habits of mother from somewhat scattered remarks on the nature of the home and the cleanliness of the baby and the carefulness of the mother. We are not therefore in a position to correct properly for parental habits the association of the feeding with the health of the baby, as we have been able to do in the case of our M.O.H. infant material.

But the correlations are generally so low that we are compelled to conclude that the nature of the feeding is not of that primary importance which is usually attributed to it. Before we investigate directly this point, it is desirable to study the extent to which the method of feeding depends upon the Mother's Health. We have considered the number of months of wholly breast feeding in relation to (*a*) Mother's Health before pregnancy and (*b*) Mother's Health after confinement. Further, we have considered the number of months of artificial feeding in relation to the same two types of Mother's Health. The following are the tables:

TABLE XXX. *Mother's Health before Pregnancy and Period of Wholly Breast Feeding.*

Class of Breast Feeding	Boys					Class of Breast Feeding	Girls				
	Mother's Health				Totals		Mother's Health				Totals
	Strong	Good	Indifferent	Poor			Strong	Good	Indifferent	Poor	
I	13	218	50	21	302	I	22	207	35	14	278
II	19	108	25	9	161	II	8	103	25	10	146
III	5	79	25	14	123	III	5	67	22	10	104
IV	3	85	21	5	114	IV	4	59	20	7	90
V	14	98	34	22	168	V	6	111	27	16	160
VI	4	71	20	11	106	VI	1	52	18	14	85
Totals...	58	659	175	82	974	Totals...	46	599	147	71	863

TABLE XXXI. *Mother's Health after Confinement and Period of Wholly Breast Feeding.*

Class of Breast Feeding	Boys					Class of Breast Feeding	Girls				
	Mother's Health				Totals		Mother's Health				Totals
	Strong	Good	Indifferent	Poor and Dead			Strong	Good	Indifferent	Poor and Dead	
I	8	145	45	18	216	I	12	138	25	19	194
II	9	82	22	9	122	II	3	89	19	11	122
III	2	67	20	10	99	III	3	60	18	8	89
IV	0	77	14	5	96	IV	2	44	23	5	74
V	1	89	27	22	139	V	1	87	32	16	136
VI	0	47	9	9	65	VI	0	35	11	10	56
Totals...	20	507	137	73	737	Totals...	21	453	128	69	671

TABLE XXXII. *Mother's Health before Pregnancy and Period of Artificial Feeding.*

Class of Artificial Feeding	Boys					Class of Artificial Feeding	Girls				
	Mother's Health				Totals		Mother's Health				Totals
	Strong	Good	Indifferent	Poor			Strong	Good	Indifferent	Poor	
I	13	218	50	21	302	I	22	207	35	14	278
II	19	134	39	14	206	II	11	129	35	12	187
III	10	125	34	11	180	III	4	104	29	15	152
IV	1	47	8	13	69	IV	3	35	11	8	57
V	13	83	30	17	143	V	6	86	21	11	124
VI	4	71	20	11	106	VI	1	52	18	14	85
Totals...	60	678	181	87	1006	Totals...	47	613	149	74	883

TABLE XXXIII. *Mother's Health after Confinement and Period of Artificial Feeding.*

Class of Artificial Feeding	Boys					Class of Artificial Feeding	Girls				
	Mother's Health				Totals		Mother's Health				Totals
	Strong	Good	Indifferent	Poor and Dead			Strong	Good	Indifferent	Poor and Dead	
I	8	145	45	18	216	I	12	138	25	19	194
II	10	107	33	16	166	II	4	107	25	14	150
III	1	111	23	10	145	III	2	90	33	11	136
IV	0	35	8	7	50	IV	2	31	12	5	50
V	1	78	24	18	121	V	2	58	25	12	97
VI	0	47	9	9	65	VI	0	35	11	10	56
Totals...	20	523	142	78	763	Totals...	22	459	131	71	683

There are various ways of obtaining a measure of the association of these eight tables. We may represent the categories of wholly breast and of artificial feeding by their range middles. Thus:

Categories	I	II	III	IV	V	VI	
Wholly breast fed ...	12	10·5	7·5	4·5	1·5	0	months
Artificially fed ...	0	1·5	4·5	7·5	10·5	12	months

But it is not entirely satisfactory to group the contents of such large subranges at their midpoints. Still, by doing this we get comparatively smooth diagrams, and a form of result which roughly expresses the truth and is intelligible to the non-statistical.

TABLE XXXIV. *Mean Number of Months.*

Mother's Health	Boys				Girls			
	Before Pregnancy		After Birth		Before Pregnancy		After Birth	
	Breast	Artificial	Breast	Artificial	Breast	Artificial	Breast	Artificial
Strong	7·37	4·43	10·35	1·50	8·97	2·81	9·93	2·32
Good	7·39	4·19	7·06	4·41	7·51	4·00	7·44	3·98
Indifferent ...	6·83	4·57	7·48	4·04	6·65	4·71	6·14	5·12
Poor	6·18	5·50	6·04	5·37	5·68	5·80	6·52	4·99
All Mothers ...	7·19	4·38	7·13	4·36	7·29	4·21	7·17	4·25

The figures in the above tables are the mean number of months of wholly breast feeding and of artificial feeding respectively of mothers whose healths before pregnancy and after birth are given by the four categories of the first column. Partly owing to the fact that our total populations in each case are different*, partly owing to the fact that our categories for breast feeding are for months of *wholly* breast feeding, the sum of months of breast feeding and artificial feeding do not add up to twelve. Only in one case, however, where the numbers are small, that of mothers of girls strong after birth, do the months slightly exceed twelve; this is due to the addition of the information as to after health of one baby who happened to be artificially fed for a long period.

While the results are not very smooth, they indicate a decreasing amount of wholly breast feeding, and an increasing amount of artificial feeding with worse maternal health, whether it be judged before pregnancy or after birth. The average amount for all mothers of wholly breast feeding is about 7·2 months, and 4·3 months of artificial feeding†; the remaining half-month must be looked upon as the average period of mixed feeding. It would thus seem that mixed feeding is not on the average of long duration. Of boys 31 °/。 are wholly breast fed for a year, and 48 °/。 are breast fed for nine months or more; the corresponding numbers for girls are 32 $^\circ/_\circ$ and 49 $^\circ/_\circ$. Of boys 10·5 $^\circ/_\circ$ are artificially fed for the whole twelve months and 25 $^\circ/_\circ$ for nine months or more. The corresponding numbers for girls are 9·6 $^\circ/_\circ$ and 23·7 $^\circ/_\circ$. Roughly therefore 50 $^\circ/_\circ$ of babies in this town are wholly breast fed for nine months and more, and 25 $^\circ/_\circ$ are artificially fed for nine months or more. The remaining 25 $^\circ/_\circ$ fall between these extremes.

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* Sometimes the Mother's Health is given only before, sometimes only after, sometimes both before and after confinement, etc.

† Slightly less breast feeding for the boys and slightly more artificial feeding.

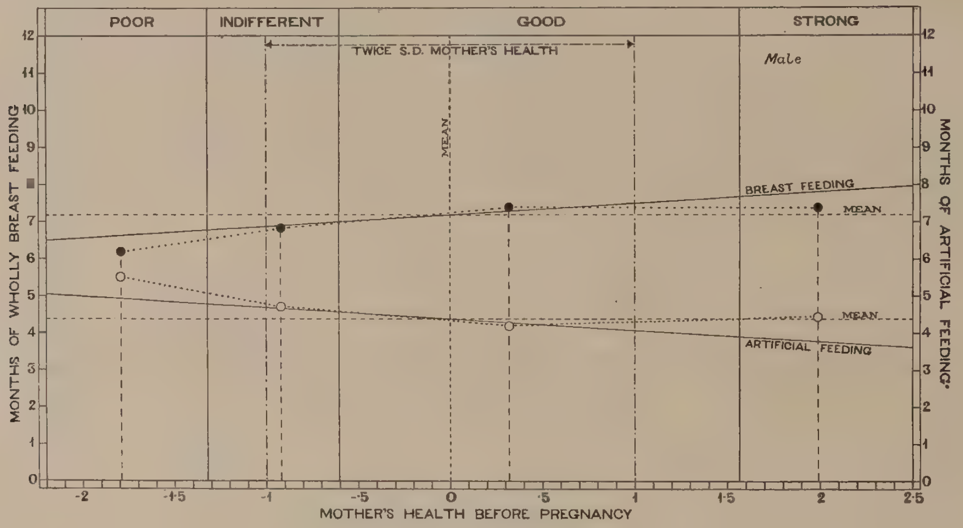

DIAGRAM VI.

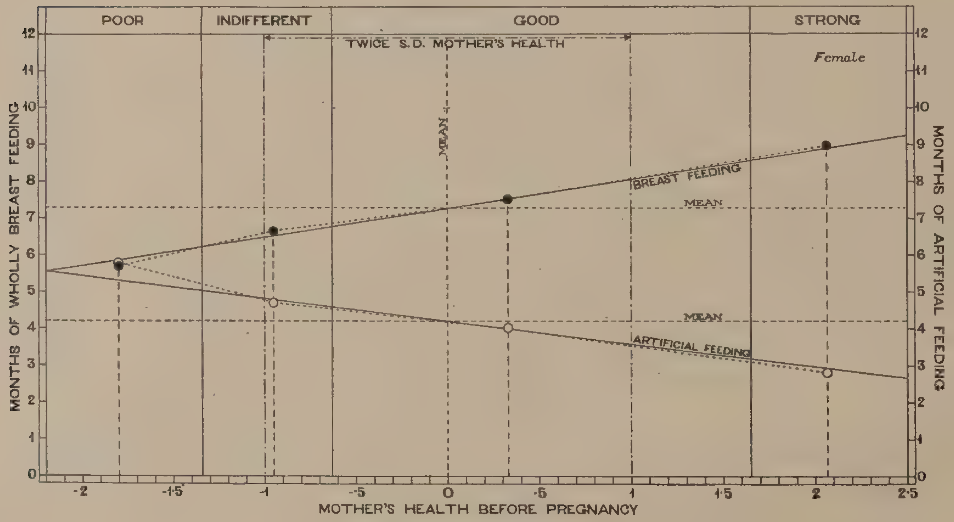

DIAGRAM VII.

Of the 25 $^\circ/_\circ$ artifically fed babies for nine months or more 38 $^\circ/_\circ$ of mothers of girls were in indifferent or poor health (or dead), and 32 $^\circ/_\circ$ of mothers of boys, or 62 $^\circ/_\circ$ (girls) and 68 $^\circ/_\circ$ (boys) of mothers with long period artificially fed children had other reasons than health for artificial feeding. These form 16·5 $^\circ/_\circ$ of all mothers of boys and 14 $^\circ/_\circ$ of all mothers of girls. Our data do not enable us to say what cogent reasons other than poor health after birth may have existed for this 15 $^\circ/_\circ$ of intensive artificial feeding*; we have to bear in mind, however, that the necessity for artificial feeding may arise as well from the infant as from the mother.

If we now turn to look at our results from the standpoint of correlation we may obtain a measure in various ways. We may give Mother's Health a normal scale and proceed to product-moment correlation on the basis of the means of our array just tabled, naturally using the class-index correction for Mother's Health. Or, we may find r by dealing with the arrays for each category of breast feeding, assuming these arrays to be normal distributions. Each of these methods will also provide a correlation ratio. The resulting values in the case of Mother's Health before pregnancy and period of wholly breast feeding are:

$$\textit{Boys}\quad \begin{cases} r_1 = \cdot 0920 \pm \cdot 0214 & r_2 = \cdot 0708 \pm \cdot 0215 \\ \eta_1 = \cdot 1001 \pm \cdot 0214 & \eta_2 = \cdot 0937 \pm \cdot 0214 \end{cases}$$

$$\text{Mean } r = \cdot 0814$$

$$\textit{Girls}\quad \begin{cases} r_1 = \cdot 1475 \pm \cdot 0225 & r_2 = \cdot 1982 \pm \cdot 0221 \\ \eta_1 = \cdot 1736 \pm \cdot 0223 & \eta_2 = \cdot 2282 \pm \cdot 0218 \end{cases}$$

$$\text{Mean } r = \cdot 1728$$

It is clear that the association of the mother's health with the amount of breast feeding is nearly double in the case of girls to what it is in that of boys. The intensity in the latter case is weakened by the relatively low mean period during which mothers of strong health wholly breast feed boy babies: it is somewhat less than the corresponding mean period for mothers of good health. Diagrams VI and VII exhibit the regression lines of breast feeding on Mother's Health. They show that the 'strong' mothers give about a month longer wholly breast feeding to the boys and about two months longer to the girls than the average mothers. But even in the case of the female infants the correlation of the extent of whole breast feeding and of mother's general health before pregnancy is of no marked intensity although quite significant.

If we now turn to Mother's Health before pregnancy and the extent of artificial feeding we find

$$\textit{Boys}\quad r_1 = -\cdot 0653 \pm \cdot 0212 \qquad r_2 = -\cdot 0751 \pm \cdot 0211$$

$$\text{Mean } r = -\cdot 0702 \pm \cdot 0212$$

$$\textit{Girls}\quad r_1 = -\cdot 1398 \pm \cdot 0223 \qquad r_2 = -\cdot 1837 \pm \cdot 0219$$

$$\text{Mean } r = -\cdot 1617 \pm \cdot 0221$$

These results are closely in accordance with those for wholly breast feeding.

Lastly, turning to Mother's Health after birth, we have for wholly breast feeding:

$$\textit{Boys}\quad \begin{cases} r_1 = \cdot 0838 \pm \cdot 0247 \\ \eta_1 = \cdot 1722 \pm \cdot 0241 \end{cases}$$

$$\textit{Girls}\quad \begin{cases} r_1 = \cdot 1441 \pm \cdot 0255 \\ \eta_1 = \cdot 1898 \pm \cdot 0251 \end{cases}$$

and for extent of artificial feeding:

$$\textit{Boys}\quad r_1 = -\cdot 0786 \pm \cdot 0243$$

$$\textit{Girls}\quad r_1 = -\cdot 1349 \pm \cdot 0253$$

---

* The data do not distinguish as some we have from the M.O.H. investigations between optional and compulsory artificial feeding. The former may be due to return to work, and the latter to absence of milk or to difficulties associated with the infant itself.

Both sets of results again tending to confirm each other, we have not thought it needful to work out the η for all the cases.

The results generally show that the relation between feeding and health of mother is about ·1, a little less for boys and a little more for girls. The correlation ratios vary from ·1 to ·2, suggesting that the relation may not be absolutely linear. Our Diagrams VIII and IX, however, do not indicate that anything better than linear regression is likely to be successful on the basis of the present data.

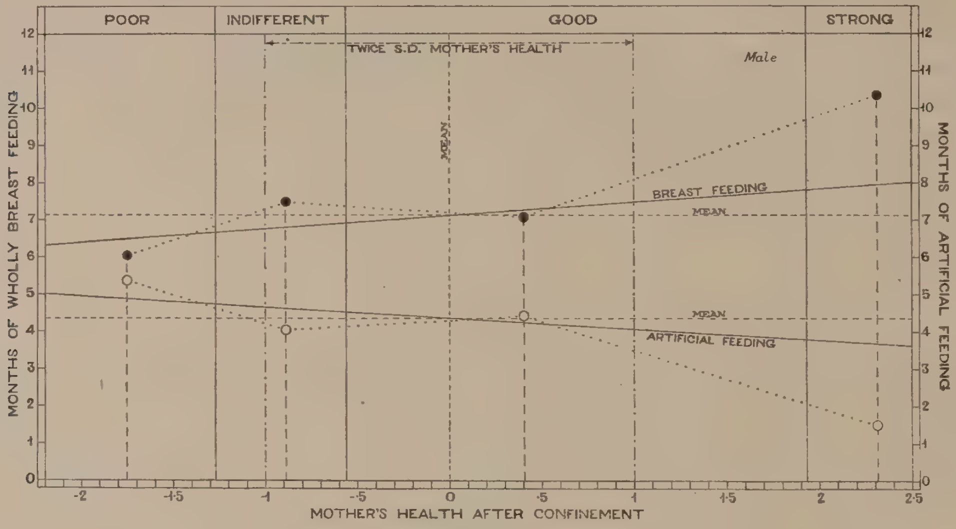

DIAGRAM VIII.

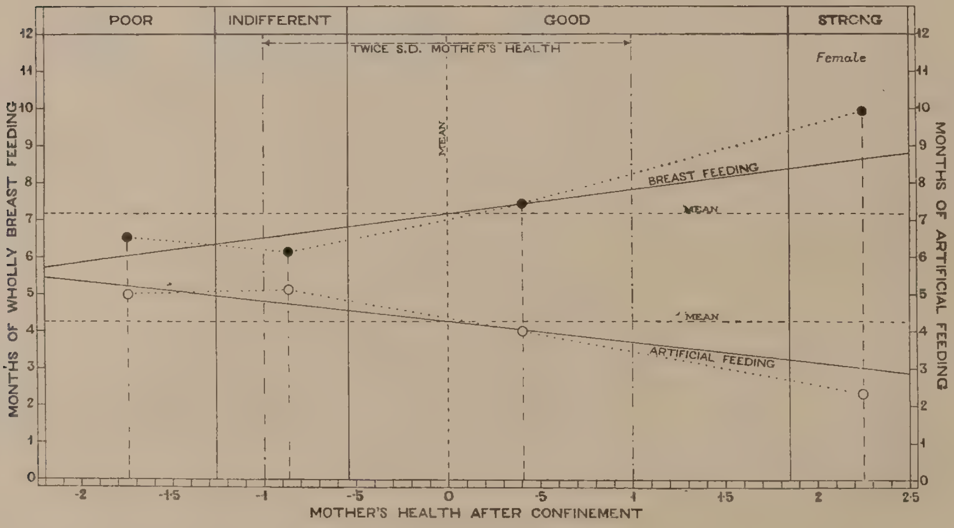

DIAGRAM IX.

Another point which seemed worthy of investigation was whether there was any significant relation between the method of feeding and such measure of Home Conditions as we were able to deduce from the schedules. We had to confine ourselves to three broad categories of homes: I, Good, II, Fair, and III, Poor.

The tables were as follows :

TABLE XXXV.

Class of Feeding (whether Breast or Artificial)	Breast Feeding. Home								Artificial Feeding. Home							
	Boys				Girls				Boys				Girls			
	I	II	III	Totals	I	II	III	Totals	I	II	III	Totals	I	II	III	Totals
I	39	15	29	83	30	18	22	70	39	15	29	83	30	18	22	70
II	34	9	14	57	29	8	18	55	44	12	20	76	36	10	24	70
III	22	7	13	42	20	6	9	35	33	8	13	54	30	10	16	56
IV	14	6	9	29	16	5	8	29	4	7	7	18	11	3	2	16
V	30	13	9	52	30	9	12	51	23	8	8	39	21	5	5	31
VI	10	1	8	19	5	5	6	16	10	1	8	19	5	5	6	16
Totals ...	149	51	82	282	130	51	75	256	153	51	85	289	133	51	75	259
Correlation	$r = -\cdot 0600 \pm \cdot 0400$				$r = -\cdot 0524 \pm \cdot 0420$				$r = -\cdot 0180 \pm \cdot 0397$				$r = -\cdot 0176 \pm \cdot 0419$			

It is clear that all the correlations, having regard to their probable errors, are insignificant*, or home conditions are not factors in feeding.

The negative correlation with breast feeding signifies that there is more breast feeding in the worse home conditions. Actually the means are, for boys and girls together :

Good	Home	Conditions,	Breast	Feeding,	7·27	months
Fair	,,	,,	,,	,,	7·40	,,
Bad	,,	,,	,,	,,	7·78	,,
All Homes			,,	,,	7·44	,,

Thus the worse homes have mothers who nurse about 10 days longer, and the best homes mothers who nurse about 5 days less than the average.

The negative correlation for artificial feeding means that the worse homes have the less artificial feeding. Actually the means for boys and girls combined are :

Good	Home	Conditions,	Artificial	Feeding,	4·05	months
Fair	,,	,,	,,	,,	3·90	,,
Bad	,,	,,	,,	,,	3·55	,,
All Homes			,,	,,	3·88	,,

Thus the worse homes have about 10 days less artificial feeding, and the better homes about 5 days longer.

When it is remembered that the standard deviation in length of feeding, or the variability in individual mothers, is about four months, it will be seen that these slight differences correspond with the low correlations.

We now turn to the main question of how the general health of the infant at 12 months is related to the manner of feeding. We deal first with the influence of the length of time of wholly breast feeding.

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* We tried grouping boys and girls together to get more data and found for breast feeding

$$r_1 = -\cdot 0481 \pm \cdot 0290 \quad r_2 = -\cdot 0576 \pm \cdot 0290$$

again of no significance.

TABLE XXXVI.

Categories of Health	Boys							Girls						
	Categories of Breast Feeding						Totals	Categories of Breast Feeding						Totals
	I	II	III	IV	V	VI		I	II	III	IV	V	VI	
I. Very Satisfactory...	9	7	1	5	5	5	32	5	6	3	0	2	2	18
II. Satisfactory	67	42	38	22	38	11	218	47	49	28	21	28	17	190
III. Normal	79	66	45	31	55	38	314	99	48	41	33	58	20	299
IV. Indifferent	31	15	11	13	13	12	95	16	17	9	8	21	11	82
V. Unsatisfactory ...	30	19	16	24	31	20	140	22	13	18	17	20	15	105
Totals	216	149	111	95	142	86	799	189	133	99	79	129	65	694

There are, assuming normality of distribution, two methods of finding the correlation, i.e. from the means of the horizontal arrays (r_1), or from those of the vertical arrays (r_2). We find:

TABLE XXXVII.

Boys	Girls
$r_1 = \cdot 1121 \pm \cdot 0236$	$r_1 = \cdot 1155 \pm \cdot 0253$
$r_2 = \cdot 1152 \pm \cdot 0235$	$r_2 = \cdot 1508 \pm \cdot 0250$
Mean $r = \cdot 1137 \pm \cdot 0235$	Mean $r = \cdot 1331 \pm \cdot 0251$
$\eta_1 = \cdot 1355 \pm \cdot 0234$	$\eta_1 = \cdot 1484 \pm \cdot 0250$

These results indicate that while the correlation of baby's health and amount of breast feeding is significant, it is not a very close one. See Diagrams X and XI.

We now turn to artificial feeding and baby's health at 12 months and have the following tables:

TABLE XXXVIII.

Categories of Health	Boys							Girls						
	Categories of Artificial Feeding						Totals	Categories of Artificial Feeding						Totals
	I	II	III	IV	V	VI		I	II	III	IV	V	VI	
I. Very Satisfactory...	9	5	5	4	5	5	33	5	9	1	0	1	2	18
II. Satisfactory	67	59	46	6	33	11	222	47	55	38	19	17	17	193
III. Normal	79	84	56	24	40	38	321	99	68	60	20	43	20	310
IV. Indifferent	31	17	19	8	10	12	97	16	20	11	8	18	11	84
V. Unsatisfactory ...	30	22	31	10	33	20	146	22	19	25	10	20	15	111
Totals	216	187	157	52	121	86	819	189	171	135	57	99	65	716

We have for the correlation coefficients:

TABLE XXXIX.

Boys	Girls
$r_1 = -·1306 \pm ·0232$ $r_2 = -·1286 \pm ·0232$ Mean $r = -·1296 \pm ·0232$ $\eta_1 = ·1346 \pm ·0231$	$r_1 = -·1655 \pm ·0245$ $r_2 = -·1290 \pm ·0248$ Mean $r = -·1472 \pm ·0247$ $\eta_1 = ·1720 \pm ·0245$

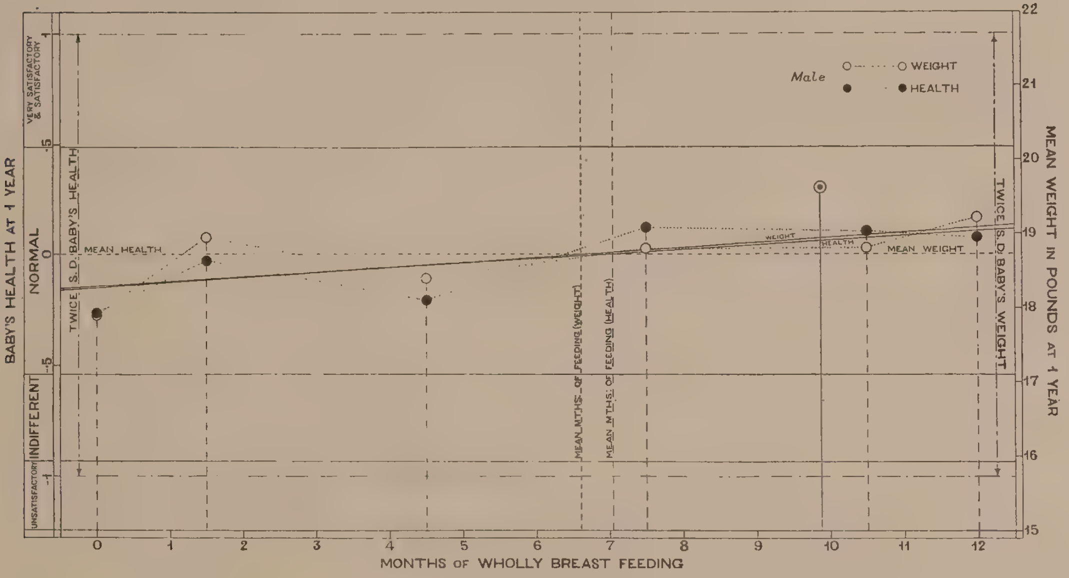

DIAGRAM X.

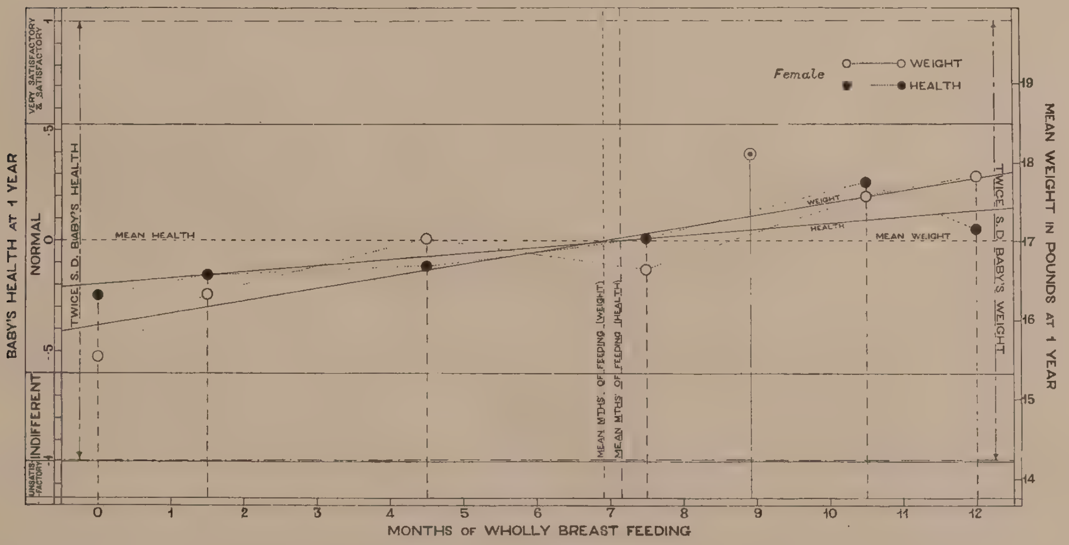

DIAGRAM XI.

It will be obvious that these relations are of precisely the same order as those found for periods of wholly breast feeding. Our Diagrams XII and XIII show that the range of health associated with the most different degrees of artificial feeding does not suffice to carry the health of the mean baby for any amount of artificial feeding outside the normal range of health.

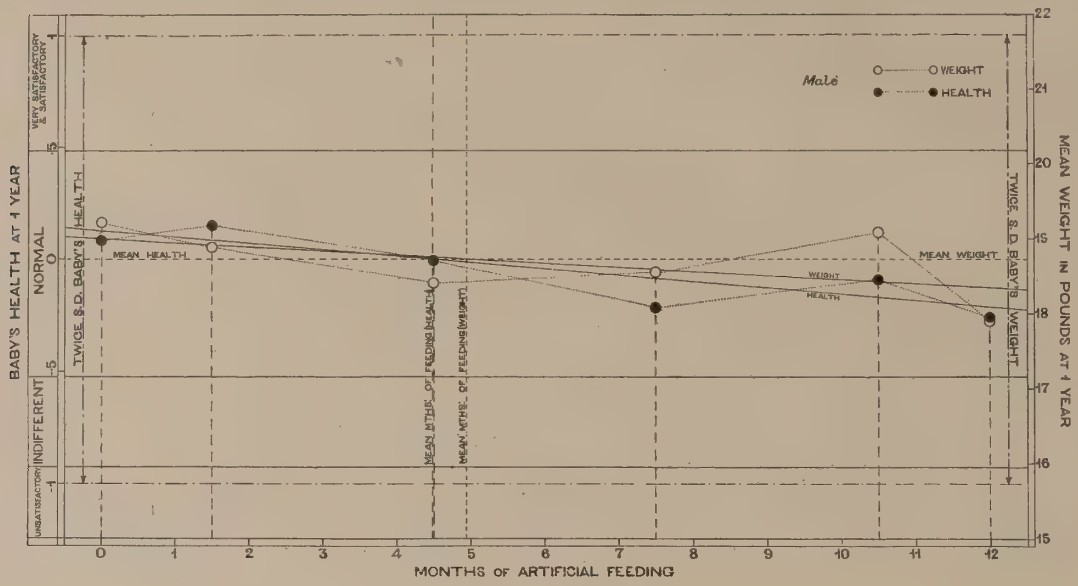

DIAGRAM XII.

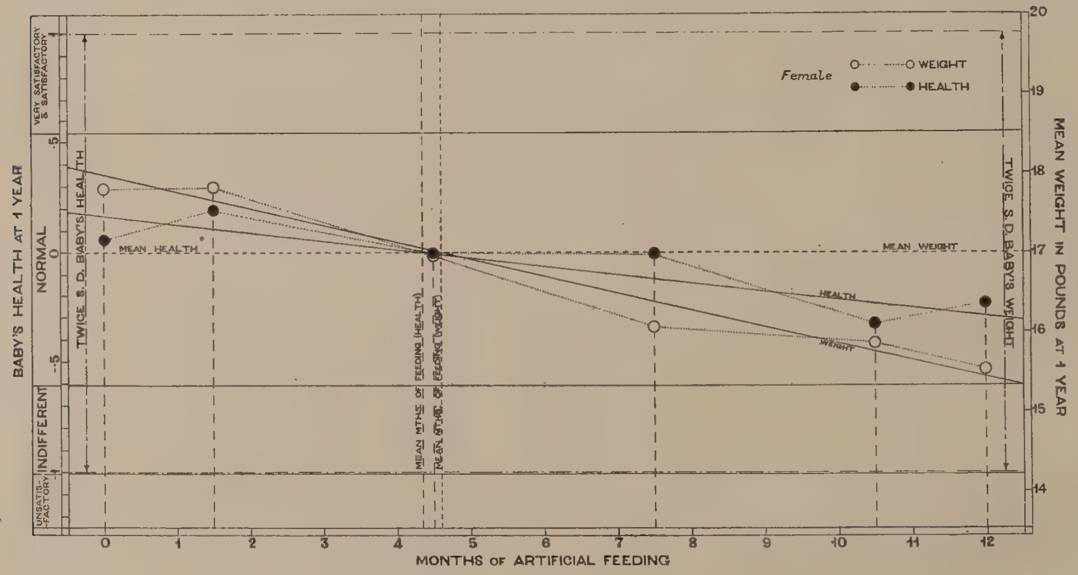

DIAGRAM XIII.

It would indeed be idle to interpret even the association of health with feeding as we find it as *causation*. On the contrary, there are many reasons for believing it is not. When a baby is congenitally feeble, it probably would not thrive on any feeding, but there is a not uncommon tendency to suggest a change of food, or even to attribute the feebleness to defective maternal milk. Thus artificial feeding is often resorted to in the case of the feeblest babies, and their mass-statistics indicate an apparently close association between poor health and artificial feeding! It is only too clear to us that in future observations at baby-clinics it is essential:

(i) that the exact reasons for starting artificial feeding should be stated;

(ii) that there should be a more or less standardised method of classing the general health of the baby.

Until these points are adequately regarded it will be impossible to determine how much of this not very important association of feeding and health is a true causation. At best if it were all causation, feeding is not a more weighty factor than clothing or home conditions.

Roughly we can approach the matter from another standpoint by noting the average amounts of breast and artificial feeding given to the various classes of health. If we take the nine available categories the results are very erratic, but dividing into four broad classes, we have:

TABLE XL. *Months of Feeding.*

Health Classes	Months of Feeding			
	Wholly Breast		Artificial	
	Boys	Girls	Boys	Girls
Very Satisfactory and Satisfactory	7·62	7·56	3·89	3·94
Normal	7·01	7·47	4·47	3·91
Indifferent	7·26	6·16	4·33	5·48
Unsatisfactory	5·96	6·11	5·71	5·46
All Classes	7·05	7·14	4·49	4·35

Here the whole problem is seen at a glance: Is the month and a half less breast feeding, the month and a half more artificial feeding, which marks the babies of unsatisfactory health, the source of their bad health, or is their bad health the reason why artificial feeding was practised? When we recollect that the mother's health is as highly associated with the period of feeding as the baby's health, and when we allow for the influence of congenital feebleness on the nature of feeding, it appears difficult to lay as much stress on the relation of breast feeding to infantile health as some authorities have hitherto done.

If the criticism be raised that the defect lies in the health categories, we can only reply by asking what better categories and more extensive material have our critics behind their convictions. If it exists, let us have it on the table and no longer appeal to convictions and impressions often based on limited and ill-digested experience*.

We can indeed support generally the conclusions reached for health by an appeal to our data for weight. The weight of babies is by no means an absolute index of their general health, as we shall see, but it is not without value as confirmatory evidence. The following four tables give the associations between periods of wholly breast and of artificial feeding, with weight. In order to get a reasonably adequate number of measurements we had to use all babies measured in the 49th to 55th week, restricting, however, our feeding categories to the history of the baby for the year.

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* Let us express ourselves as Sir William Petty said in terms of *number, weight or measure*, and let us leave arguments "that depend on the mutable minds, opinions, appetites and passions of particular men to the consideration of others."

These tables fully confirm for boys the conclusions already reached, i.e. there is no very important relation between weight and method of feeding, and the correlation of the latter with weight is less than with health.

TABLE XLI. *Weight of Male Babies and Feeding.*

Weight in lbs. at 49—55 weeks	Extent of Artificial Feeding							Extent of Breast Feeding						
	I	II	III	IV	V	VI	Totals	VI	V	IV	III	II	I	Totals
10—*	—	1	—	—	—	3	4	3	—	—	—	1	—	4
11—	1	—	4	—	3	—	8	—	4	3	—	—	1	8
12—	2	2	—	—	1	4	9	4	—	1	1	1	2	9
13—	1	8	—	—	5	6	20	6	4	1	6	2	1	20
14—	7	6	10	1	3	3	30	3	2	4	3	11	7	30
15—	6	10	9	4	5	—	34	—	11	—	5	10	6	32
16—	9	7	13	8	4	6	47	6	11	7	8	5	9	46
17—	21	21	13	7	6	10	78	10	10	7	7	20	21	75
18—	17	13	19	4	11	22	86	22	11	14	7	12	17	83
19—	15	14	22	17	9	16	93	16	7	30	4	16	15	88
20—	16	26	13	2	9	9	75	9	11	5	9	24	16	74
21—	11	17	9	6	11	3	57	3	17	5	4	17	11	57
22—	6	10	4	1	6	2	29	2	8	2	3	8	6	29
23—	8	4	2	—	5	1	20	1	5	—	4	2	8	20
24—	8	—	1	—	—	—	9	—	—	—	1	—	8	9
25—	2	2	3	—	1	1	9	1	1	—	4	1	2	9
26—	—	1	—	—	1	—	2	—	1	—	1	—	—	2
27—	—	1	—	—	1	—	2	—	1	—	—	1	—	2
28—	—	—	—	—	1	—	1	—	1	—	—	—	—	1
Totals ...	130	143	122	50	82	86	613	86	105	79	67	131	130	598
Correlation Coefficients	$r = -\cdot 0910 \pm \cdot 0270$							$r = \cdot 0964 \pm \cdot 0273$						

The results for the girls differ from those for the boys in showing considerably higher correlation. Diagrams X—XIII, pp. 29, 30, however, indicate that it is quite in accordance with the facts. The female infant's weight is more intimately associated with the method of feeding than that of the male infant. We further see that its weight is more closely associated with its feeding than its health is, exactly the reverse of what we find in the case of boys. We have no real explanation to give of this phenomenon, but we would remark that the female baby appears to have higher correlations all round. It is not only that weight and health are more closely related to feeding in girls than boys, but it appears as if girls were more subject to environmental influences. It is not desirable to theorise in the present state of our knowledge, but it would be of interest to ascertain whether in Infants' Hospitals and Baby Clinics the girls respond more to treatment than boys, or whether it is especially in matters associated with the mother that this greater correlation exists, for even the 'environment' of a baby is largely maternal. We are at present so wholly ignorant of what it is that makes one baby thrive and another fail that any clue almost is worth following up, even if only one in a dozen leads us anywhere.

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* The weighing being made to ozs. any weight over 9 lbs. 15½ oz. would be considered as 10 lbs., the range of the group "10—" is accordingly 9·9688—10·9688 or the mid subrange is 10·4688, and so on. This point is essential for the determination of array means.

TABLE XLII. *Weight of Female Babies and Feeding.*

Weight in lbs. at 49—55 weeks	Extent of Artificial Feeding							Extent of Breast Feeding						
	I	II	III	IV	V	VI	Totals	VI	V	IV	III	II	I	Totals
8—*	—	—	—	—	1	—	1	—	1	—	—	—	—	1
9—	—	—	—	1	—	1	2	1	—	—	—	—	—	1
10—	2	—	—	1	—	5	8	5	—	1	—	—	2	8
11—	1	6	1	3	2	1	14	1	1	5	—	6	1	14
12—	—	—	2	3	5	4	14	4	5	—	5	—	—	14
13—	3	2	8	4	11	6	34	6	9	8	5	2	3	33
14—	16	3	9	3	6	6	43	6	5	8	5	3	16	43
15—	8	6	15	1	2	8	40	8	3	6	9	6	8	40
16—	11	21	15	8	13	6	74	6	20	3	9	22	11	71
17—	14	16	20	6	11	3	70	3	14	15	11	13	14	70
18—	25	14	16	1	5	6	67	6	10	7	16	3	25	67
19—	15	25	7	1	5	6	59	6	2	11	5	20	15	59
20—	11	9	3	3	—	3	29	3	—	5	1	8	11	28
21—	4	4	4	3	1	—	16	—	2	4	1	3	4	14
22—	4	4	3	1	—	—	12	—	1	3	—	4	4	12
23—	2	—	—	—	1	—	3	—	1	—	—	—	2	3
24—	2	—	—	—	—	—	2	—	—	—	—	—	2	2
Totals ...	118	110	103	39	63	55	488	55	74	76	67	90	118	480
Correlations	$r=-\cdot 3172 \pm \cdot 0275$							$r=\cdot 2534 \pm \cdot 0288$						

Finally if we sum up our results for baby's health and feeding and correct them for mother's health before pregnancy† we have for partial correlations:

TABLE XLIII.

Health of Baby	Wholly breast feeding	Artificial feeding
Boys	$r=\cdot 1176 \pm \cdot 0235$	$r=-\cdot 1237 \pm \cdot 0232$
Girls	$r=\cdot 1203 \pm \cdot 0252$	$r=-\cdot 1260 \pm \cdot 0248$

all significant in intensity, but of very small practical value as indicating definite lines of treatment.

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* 7·9688—8·9688: see last footnote.

† If we correct also for home conditions the correlations are only altered in the last place of decimals. For example $r=\cdot 1176$ becomes ·1171.

Note. **On Mother's Health.** We have used in this section Mother's Health before pregnancy and after confinement. Besides Mother's Health before pregnancy and Mother's Health after the Birth of Baby, we have data for mother's 'Health during Pregnancy.' We can form three tables between these three phases of health in the mother and determine the relationships between the three. We have:

TABLE XLIV.

Mother's Health during Pregnancy	Mother's Health before Pregnancy				Totals	Mother's Health after Confinement				Totals
	Strong	Good	Indifferent	Poor		Strong	Good	Indifferent	Poor and Dead	
Strong	45	1	—	—	46	38	3	2	1	44
Good	26	895	71	20	1012	1	894	73	31	999
Indifferent ...	14	135	153	39	341	5	115	169	36	325
Poor	3	62	28	72	165	1	41	46	76	164
Totals	88	1093	252	131	1564	45	1053	290	144	1532

Mother's Health after Birth	Mother's Health before Pregnancy				Totals
	Strong	Good	Indifferent	Poor	
Strong	44	2	0	1	47
Good	30	949	85	24	1088
Indifferent ...	11	105	142	44	302
Poor and Dead ...	4	61	27	63	155
Totals	89	1117	254	132	1592

In these tables we have included with those whose health is indifferent after birth 13 women suffering from mammary abscess*; 68 women anaemic before pregnancy and 46 anaemic after birth are also included in the 'indifferent' category.

A rough measure of the effect of pregnancy and confinement on the mother may be deduced from the fact that while before pregnancy 8·3 °/o of the mothers were in poor health and 24·2 °/o in indifferent or poor health, together 32·5 °/o, and while during pregnancy 9·9 °/o were in poor and 22·1 °/o in indifferent health, together 32·0 °/o, these numbers were increased to 9·7 °/o and 28·7 °/o respectively, together 38·4 °/o, after the birth, while the 5·6 °/o who were in the highest health category before pregnancy were reduced to 2·6 °/o during pregnancy and to just half the percentage, 2·8 °/o, after birth.

The tables all show high associations, but, owing to the far too broad category of 'Good' Health, present considerable difficulties in the way of analysis. As we need them chiefly for the purpose of intercomparison, it is probably adequate to treat them all by the same process and we place here the results obtained by contingency:

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* We find that the cases of mammary abscess were less than 0·9 °/o and the cases of dead mothers less than 0·32 °/o.

TABLE XLV.

Mothers' Healths associated	Mean Square Contingency		Mean Contingency		Correlation Coefficient Tetrachoric*
	Raw	Corrected for Class-indices	Raw	Corrected for Class-indices	
During and before Pregnancy ...	·6877	·9350 {·7941}	·6450	·7610	·7782
During Pregnancy and after birth ...	·7364	[1·0141] {·8503}	·6790	·8074	·8104
Before Pregnancy and after birth ...	·6706	·9302 {·7743}	·6400	·7634	·7745

It is clear that the relationship between healths of mother during pregnancy and after birth is the highest. The relations of health before pregnancy to that during pregnancy and to that after birth are substantially equal. The high values of the association of healths during pregnancy and after birth make it unnecessary to deal at length with mother's health during pregnancy, and we have in the main restricted our attention to mother's health before pregnancy and after confinement.

From the theoretical standpoint the corrections for 4 × 4 contingency tables with a great block under one category of both variables cannot be considered satisfactory. The class-index correlations range from ·84 to ·86 and they over-correct the mean square contingency results†, and under-correct the mean contingency results.

Probably the best method of procedure is to obtain the tetrachoric correlation. This is given in the last column, and agrees reasonably with the corrected mean contingency‡. The class-index correction applied to the mean square contingency gives, however, much too high values. Now it is known that the maximum value of the raw contingency for a table of $m \times m$ cells is $\sqrt{1-\frac{1}{m}}$, or in our case $\sqrt{1-\frac{1}{4}}=\sqrt{\cdot 75}$. It has been suggested that a corrective factor might be obtained by dividing the raw contingency coefficient by $\sqrt{1-\frac{1}{m}}$. The results are given in curled brackets, and it is seen that they are more in accordance with those obtained by the other two methods. But we have at present no adequate justification for such a method of correction; it would probably, of course, be most reasonable with high correlations. It is clear, however, that the correlation between mother's health during pregnancy and after confinement is of the order ·81, and between her health before pregnancy with either health during pregnancy or after confinement of the order ·77 or ·78. These high correlations contrast strongly with that between baby's health at first visit and baby's health at a year, which is of the order ·40.

We may illustrate that Mother's Health during Pregnancy is not so important as

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* Dichotomic lines between 'good' and 'indifferent' healths.

† In the second case they give a correlation exceeding unity slightly.

‡ Corrected, however, only by the empirical method given in *Tables for Statisticians and Biometricians*, p. lviii.

Health before Pregnancy or after confinement by considering its relationship to Feeding of Baby. We have the following four tables:

TABLE XLVI. *Mother's Health during Pregnancy and Months of Wholly Breast Feeding.*

Mother's Health	Period of Breast Feeding													
	Boys							Girls						
	I	II	III	IV	V	VI	Totals	I	II	III	IV	V	VI	Totals
Strong ...	8	6	3	1	1	0	19	11	3	2	1	3	1	21
Good ...	134	82	56	72	85	42	471	129	89	43	39	86	32	418
Indifferent	47	23	26	14	35	12	157	33	20	31	24	22	12	142
Poor ...	22	7	15	8	11	9	72	17	9	8	8	18	7	67
Totals ...	211	118	100	95	132	63	719	190	121	84	72	129	52	648
Correlation Coefficient ...	$r = \cdot 0488 \pm \cdot 0251$							$r = \cdot 1057 \pm \cdot 0262$						
Correlation Ratio (feeding on health) ...	$\eta = \cdot 1168 \pm \cdot 0248$							$\eta = \cdot 1250 \pm \cdot 0261$						

TABLE XLVII. *Mother's Health during Pregnancy and Months of Artificial Feeding.*

Mother's Health	Period of Artificial Feeding													
	Boys							Girls						
	I	II	III	IV	V	VI	Totals	I	II	III	IV	V	VI	Totals
Strong ...	8	7	3	—	1	—	19	11	3	2	3	2	1	22
Good ...	134	101	103	31	69	42	480	129	102	71	31	61	32	426
Indifferent	47	38	30	11	26	12	164	33	34	36	12	18	12	145
Poor ...	22	15	8	12	12	9	78	17	13	15	5	11	7	68
Totals ...	211	161	144	54	108	63	741	190	152	124	51	92	52	661
Correlation Coefficient ...	$r = -\cdot 0641 \pm \cdot 0247$							$r = -\cdot 0691 \pm \cdot 0261$						
Correlation Ratio (feeding on health) ...	$\eta = \cdot 1210 \pm \cdot 0244$							$\eta = \cdot 0819 \pm \cdot 0261$						

A comparison of these results with those on pp. 21 and 22 indicates that mother's health during pregnancy has somewhat less influence on the extent of wholly breast feeding than mother's health after birth or mother's health before pregnancy. But again the mother's health appears to have more influence on the feeding in the case of girls than in the case of boys. The marked differences between the correlation coefficient and the correlation ratio—especially in the case of boys—are seen to arise from the health category of 'strong.' This is obvious on examining the Diagrams XIV and XV or the following tables of means:

TABLE XLVIII.

Mother's Health during Pregnancy	Mean Months of Feeding			
	Boys		Girls	
	Wholly Breast	Artificially	Wholly Breast	Artificially
Strong	9·87	1·82	8·93	3·14
Good	7·09	4·33	7·44	4·06
Indifferent ...	7·11	4·22	6·90	4·39
Poor	6·98	4·90	6·29	4·76
All Categories ...	7·16	4·30	7·25	4·17

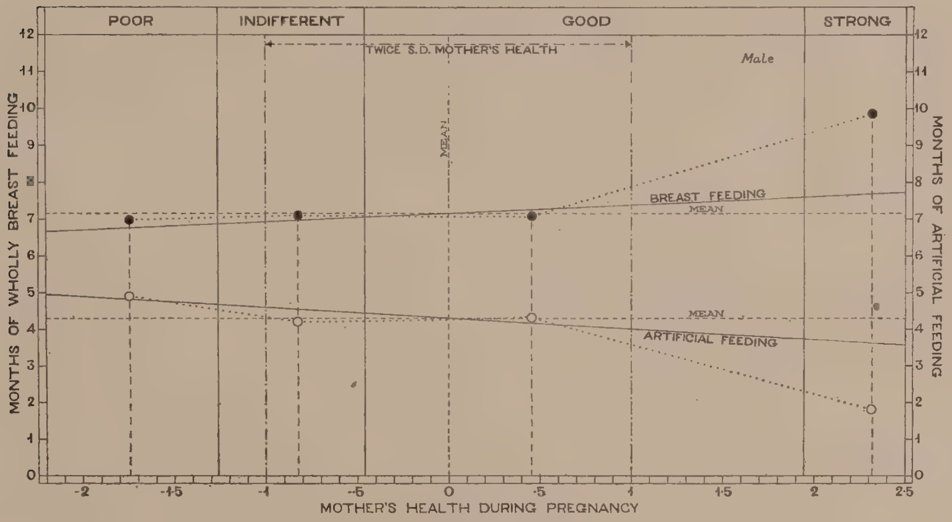

DIAGRAM XIV.

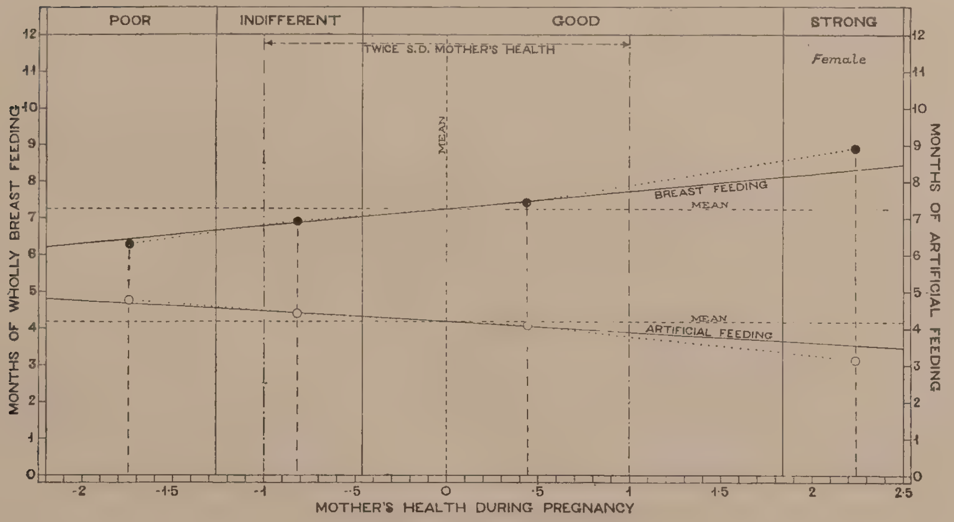

DIAGRAM XV.

We see the same points as before: the longer period of wholly breast feeding and the shorter period of artificial feeding of the girls, the average 7 months of breast feeding and 4 months of artificial feeding with the period of something under a month of mixed feeding—the weaning period. These values are, however, subject to large variations, the standard deviations in months being for breast feeding: Boys, 4·48; Girls, 4·50; and for artificial feeding: Boys, 4·29; Girls, 4·23. The diagrams indicate how for boys there is very little difference in period of breast feeding whether the mothers are in 'poor,' 'indifferent' or 'good' health, but that the divergence arises with the 'strong' mothers. With girls there is a small uniform increase as we pass from mothers of poor to those of indifferent and then to those of good health, and again we see a considerable leap upward in period of breast feeding, if not so great as with the boys, in the case of strong health. The lower three grades of health would give a linear regression, it is the strong health which upsets the linearity and raises the correlation ratio so much above the correlation coefficient. Nor can we suggest that it is the

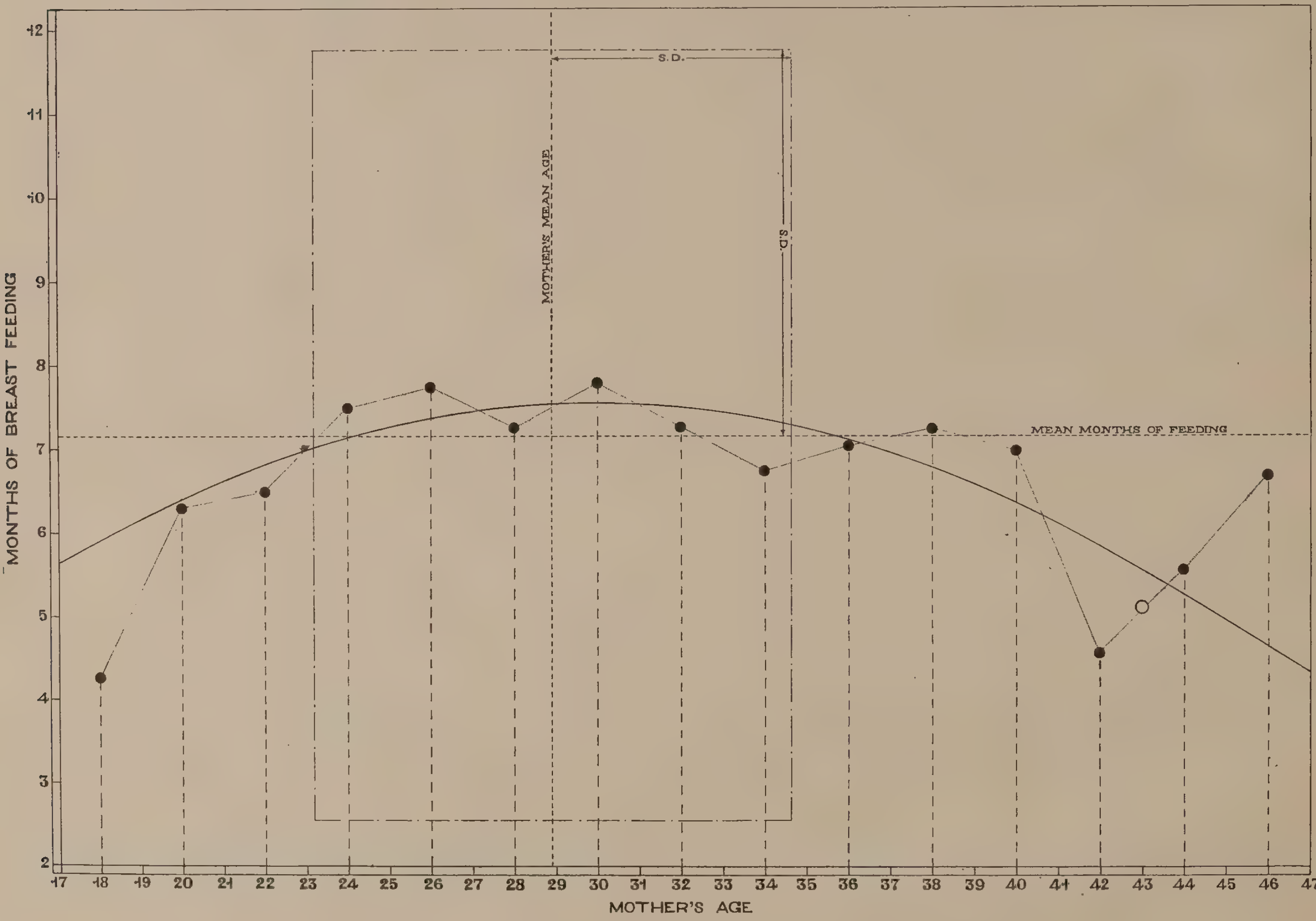

DIAGRAM XVI. (Rectangle represents the doubled standard deviations.)
The open circle signifies the mean of the last three observation points.

long period of wholly breast feeding which is the source of the mother's strong health, for we are dealing now with health *during* pregnancy. Nor can we claim that this excellent health during pregnancy enables the mother to wholly breast feed for a longer period, because as we have seen the strong during pregnancy are the strong before pregnancy. Unfortunately the mothers in the category of 'strong' health are so very few, only 2·6 °/o in the case of boys and 3·3 °/o in that of girls.

We cannot believe that there is this abrupt transition—almost a racial difference—between the bulk of the population with good health, and a vanishingly small class of 'strong' women. We believe that the class of 'good' health forming something like 65 °/o of the maternal population requires more careful health differentiation; a transference of some to the category of 'strong' and some to that of 'indifferent' health would probably lead to that uniform change in months of breast feeding with prenatal health which seems *a priori* to be the reasonable state of affairs.

The associations of mother's health with mother's age are considered later in this paper, but do not substantially modify our present results. We may consider here the association of breast feeding with mother's age. We have combined both sexes although female babies are breast fed rather longer than male babies. The following table gives the results:

TABLE XLIX.

Mother's Age centred at	Months of Breast Feeding centred at						Totals
	0	1·5	4·5	7·5	10·5	12	
18	2	—	3	—	—	1	6
20	13	13	10	14	6	21	77
22	27	40	27	26	37	46	203
24	25	42	24	19	37	88	235
26	17	44	28	33	40	92	254
28	22	41	23	19	52	60	217
30	10	33	21	21	33	64	182
32	20	22	17	22	19	53	153
34	18	27	9	11	22	36	123
36	11	29	16	19	19	41	135
38	7	17	10	17	19	23	93
40	5	7	5	7	9	10	43
42	9	6	4	4	3	4	30
44	2	1	3	1	2	1	10
46	1	1	1	1	2	1	7
Totals	189	323	201	214	300	541	1768

Mean Age 28·91 years. S. D. of Age 5·7281 years.
Mean of Breast Feeding 7·147 months. S. D. of Breast Feeding 4·6056 months.
Correlation coefficient $r = -·0141 \pm ·0160$ and is insignificant.
Correlation ratio of Breast Feeding on age $\eta = ·1307 \pm ·0157$ and is significant.

Diagram XVI indicates at once the source of this, namely the regression is skew. Fitting with a parabolic regression line, we have

$$y = 7·4909 - ·0982\,(x - 32) - ·0464\,(x - 32)^2,$$

where y = number of months breast feeding of women of x years of age.

We note that duration of suckling increases with age until mothers are 29·88 years of age and then falls fairly rapidly. We see that in this respect the human race is like other animals, however artificially modified in many particulars. Thus cows reach their maximum milk productivity at between 4 and 5 years of age and fall slowly soon after this.

The correlation ratio for age of mother on months of breast feeding is ·0427 and thus of no importance; the mother's mean ages for the several breast feeding groups are:

TABLE L.

Months	0	1·5	4·5	7·5	10·5	12	All
Years of Age ...	28·96	28·99	28·75	29·32	29·12	28·61	28·91

There is one problem, however, which we may deal with here: Do the mothers who are 'strong' during pregnancy have remarkably fine babies? The best test that we could devise seemed to be the weight of the baby at a year. Unfortunately our data are very sparse, because not only are 'strong' mothers such a small percentage of mothers, but we must limit ourselves to the 'strong' mothers whose babies were weighed between 49 and 55 weeks of age.

The following are the tables found:

TABLE LI. *Mother's Health during Pregnancy and Baby's Weight at a Year.*

Baby's Weight in lbs.	Boys					Baby's Weight in lbs.	Girls				
	Strong	Good	Indifferent	Poor	Totals		Strong	Good	Indifferent	Poor	Totals
*10—	1	3	—	—	4	8—	—	1	—	—	1
11—	—	8	—	—	8	9—	—	1	—	—	1
12—	—	2	2	2	6	10—	—	1	3	—	4
13—	—	4	3	2	9	11—	—	10	1	—	11
14—	—	8	—	2	10	12—	—	4	3	4	11
15—	—	13	13	4	30	13—	—	11	14	2	27
16—	—	25	7	3	35	14—	1	11	11	2	25
17—	—	34	15	4	53	15—	—	12	12	7	31
18—	1	39	5	10	55	16—	5	39	20	5	69
19—	1	49	11	7	68	17—	1	36	13	5	55
20—	2	40	9	10	61	18—	2	38	15	1	56
21—	—	36	7	4	47	19—	2	38	10	5	55
22—	—	19	6	—	25	20—	1	16	5	1	23
23—	—	18	1	—	19	21—	—	12	2	—	14
24—	—	7	—	—	7	22—	—	11	1	—	12
25—	—	7	1	—	8	23—	—	2	—	—	2
26—	—	1	1	—	2	24—	—	2	—	—	2
27—	—	1	—	—	1	25—	—	—	—	—	—
28—	—	1	—	—	1	26—	—	—	—	—	—
Totals	5	315	81	48	449	Totals	12	245	110	32	399

* As before the weights being to ½ ozs. in the record the mean of the group is at 10·4688 lbs.

The mean weights for each health category are:

TABLE LII.

Mother's Health during Pregnancy	Boys	Girls
Strong	17·87 lbs.	17·55 lbs.
Good	19·28 lbs.	17·66 lbs.
Indifferent ...	18·46 lbs.	16·45 lbs.
Poor	18·20 lbs.	16·25 lbs.
All Categories ...	19·00 lbs.	17·21 lbs.

Now while there is on the whole a quite sensible falling off in the average weight of the baby as mother's health passes from 'good' to 'poor,' yet in both cases the weight of the babies of 'strong' mothers is less than that of babies of mothers of 'good' health, and in the case of boys the 'strong' mothers have the lightest babies at a year of all classes. The data are too slender to be conclusive, but they certainly do not demonstrate in a marked manner that the women who are strong during pregnancy will have in an equally marked manner fine babies as judged by weight at the end of a year. The associations are:

	Boys	Girls
Correlation Coefficients ...	$r = \cdot1351 \pm \cdot0312$	$r = \cdot1983 \pm \cdot0324$
Correlation Ratios	$\eta = \cdot1734 \pm \cdot0309$	$\eta = \cdot2517 \pm \cdot0316$

These again show the greater influence of mother's health on girls than boys. The table of means gives the general sweep of the influence and indicates why the η is so much in excess of the r, i.e. the effect of the 'strong' category.

5. INFLUENCE OF CLEANLINESS OF BABY ON HEALTH OF YEARLING BABIES.

The available categories for cleanliness of baby were 'Excellent,' 'Very Clean,' 'Clean,' 'Fairly Clean' and 'Not Clean.'

The following are the tabled data:

TABLE LIII.

Cleanliness Categories	Baby's Health at Twelve Months													
	Boys							Girls						
	I	II	III	IV	V	VI	Totals	I	II	III	IV	V	VI	Totals
Excellent ...	5	2	14	1	3	1	26	1	1	9	4	1	1	17
Very Clean	8	35	61	13	15	16	148	6	30	45	13	15	14	123
Clean ...	14	151	193	47	99	51	555	6	127	201	41	62	49	486
Fairly Clean	2	17	27	20	12	10	88	2	17	29	16	19	14	97
Not Clean	0	2	7	6	4	5	24	0	5	8	2	3	2	20
Totals ...	29	207	302	87	133	83	841	15	180	292	76	100	80	743

The correlations may be found by taking either the arrays of health for a given grade of cleanliness or the arrays of cleanliness for a given grade of health to be normal distributions. Let these be r_1 and r_2 respectively. Then we have:

TABLE LIV.

Boys	Girls
$r_1 = \cdot 1340 \pm \cdot 0228$	$r_1 = \cdot 0840 \pm \cdot 0245$
$r_2 = \cdot 1014 \pm \cdot 0230$	$r_2 = \cdot 0765 \pm \cdot 0246$
$\eta_1 = \cdot 1785 \pm \cdot 0226$	$\eta_1 = \cdot 0983 \pm \cdot 0245$
$\eta_2 = \cdot 1880 \pm \cdot 0225$	$\eta_2 = \cdot 1854 \pm \cdot 0239$

For our purposes the r_1's are the important values, and the η_1's the controls on these. They do not indicate that cleanliness of the baby is a very important factor in determining its health. On the other hand, it may be argued that the babies may have been specially cleaned up for exhibition—an argument which some might support from the fact that only something under 3 °/$_\circ$ of the babies are recorded as 'not clean' and 10 °/$_\circ$ to 13 °/$_\circ$ as only 'fairly clean.' A more reasonable view, however, is that the bulk of north-country mothers do keep their babies clean, and accordingly there is not enough differentiation in cleanliness to exhibit itself markedly in a differentiation of health. What there is is indicated in Diagrams XVII and XVIII.

We may ask how far the Cleanliness of Baby is associated with Mother's Health after Birth.

TABLE LV.

Mother's Health after Birth	Cleanliness of Baby											
	Boys					Totals	Girls					Totals
	Excellent	Very Clean	Clean	Fairly Clean	Not Clean		Excellent	Very Clean	Clean	Fairly Clean	Not Clean	
Strong ...	3	10	42	5	0	60	1	2	36	6	2	47
Good ...	22	109	425	76	21	653	13	77	435	66	19	610
Indifferent	4	31	118	17	5	175	2	29	101	14	2	148
Poor ...	0	15	57	6	2	80	2	10	45	13	4	74
Totals ...	29	165	642	104	28	968	18	118	617	99	27	879

Treating arrays of cleanliness for each health of mother as normal distributions in order to find means we have for the correlations:

Boys	Girls
$r = + \cdot 0016 \pm \cdot 0217$	$r = - \cdot 0414 \pm \cdot 0227$

Neither of these is significant.

To control, ϕ^2 and η^2 were calculated for the Boys' table. We found for uncorrected values:

$$\phi^2 = \cdot 00912, \quad \text{but } \overline{\phi}^2 = \cdot 01963,$$
$$\eta^2 = \cdot 001375, \quad \text{but } \overline{\eta}^2 = \cdot 003099.$$

Thus the contingency and correlation ratios are less than the mean values which arise when we suppose zero contingency and zero correlation. There is thus no sign of relationship between Mother's Health and the Cleanliness of the Baby.

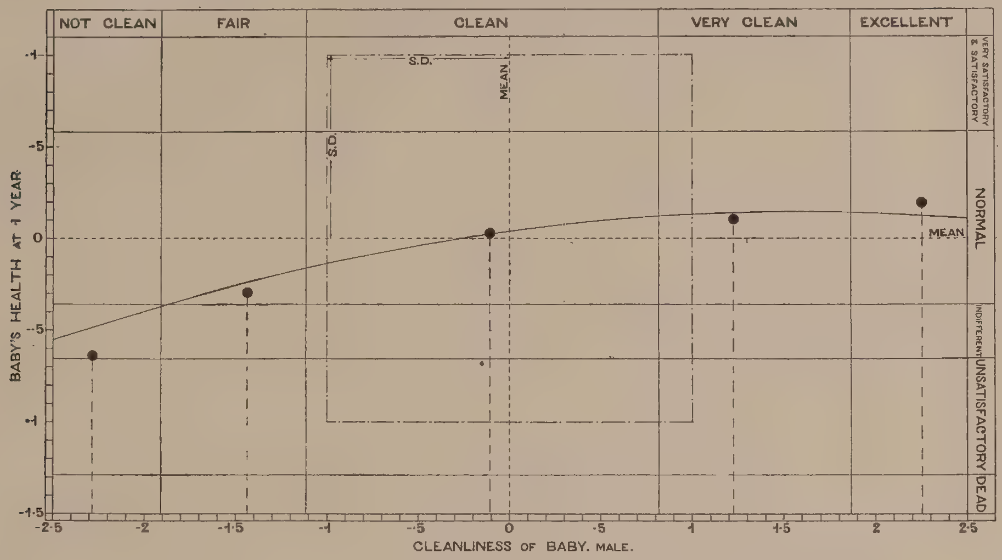

DIAGRAM XVII. (Rectangle represents the doubled standard deviations.)

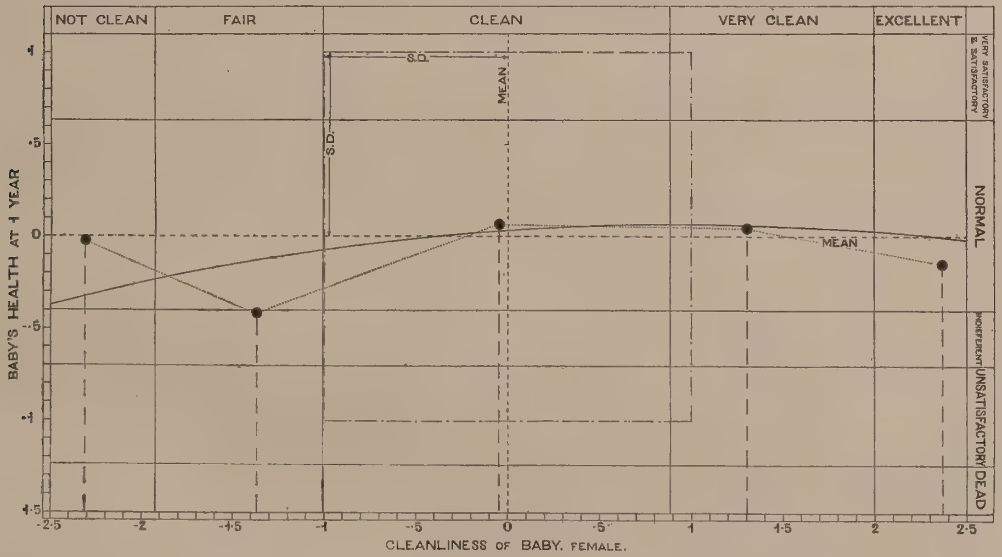

DIAGRAM XVIII. (Rectangle represents the doubled standard deviations.)

We have already seen (p. 14, ftn.) that Mother's Health is not related to the orderliness of the home. It is, however, worth while ascertaining whether the latter is related to the Cleanliness of the Baby. Our data, although slender, are conclusive.

TABLE LVI.

Home Conditions	Cleanliness of Baby											
	Boys					Totals	Girls					Totals
	Excellent	Very Clean	Clean	Fairly Clean	Not Clean		Excellent	Very Clean	Clean	Fairly Clean	Not Clean	
Good ...	2	34	116	3	—	155	1	29	95	1	1	127
Fair ...	1	9	36	6	1	53	—	12	33	6	1	52
Bad ...	—	3	42	23	11	79	—	—	34	20	16	70
Totals ...	3	46	194	32	12	287	1	41	162	27	18	249

TABLE LVII.

The correlations are for arrays of given home conditions:

Boys	Girls
$r = \cdot 5308 \pm \cdot 0286$	$r = \cdot 5679 \pm \cdot 0290$
$\eta = \cdot 6468 \pm \cdot 0232$	$\eta = \cdot 7121 \pm \cdot 0211$

Whether we take the test of the correlation coefficients or that of the correlation ratios*, it is clear that there is a very substantial relationship between the orderliness of the home and the cleanliness of the baby. The fact that neither is, however, closely correlated with Mother's Health shows us that we are dealing rather with cleanliness of home as the result of orderliness of mind or mental habit in the mother than with uncleanliness as a product of physical feebleness. A clean home connotes in a high degree a clean baby. But while orderliness of home and cleanliness of baby are only moderately related to baby's health—so that they appear to be only indicative of some more potent factor—we may raise the question whether that more potent factor is not to be found in mother's habits, of which we have in the present data no direct appreciation. Regularity of feeding, care in the preparation and preservation of artificial food all depend upon mother's orderliness of mind. A cave-dwelling palaeolithic ancestry may have inured infant humanity to superficial dirt. In modern civilisation protection from internal dangers may be of greater importance than external dirt.

6. BABY'S HEALTH AND HOME (ENVIRONMENTAL) CONDITIONS.

If we turn to the home conditions we have data to measure the relation of Baby's Health at 12 months to (*a*) Cleanliness of Home, to (*b*) Crowding of Home, to (*c*) Father's Wage, to (*d*) Rent, to (*e*) Mother's Employment before Birth, to (*f*) the Sleeping provision, to (*g*) Use of Comforter.

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* With small numbers and only *three* arrays as in the present case, we must anticipate that η will usually be much higher than r, i.e. three points will be much better fitted by a curve than a line.

(i) In most of these cases we shall naturally use Baby's Health at the end of the year, but as for some purposes Health of Baby at First Visit is of interest, we shall, as a preliminary point, discuss the relations between Health at First Visit and Health at a Year. Unfortunately the first visit at a voluntary clinic of the present kind does not always take place within a fixed date. Only about 13·8 °/₀ of the boys and 15·1 °/₀ of the girls have their healths recorded in the first fortnight; and only 51·0 °/₀ of the boys and 52·4 °/₀ of the girls within ten weeks of birth. In fact, the Health at First Visit may straggle out to almost the year itself. It becomes needful, therefore, to consider the influence of age on Health at First Visit.

The following tables give in a condensed form our data. We can here only make four health classes: Poor, Indifferent, Good, Very Good.

TABLE LVIII. *Correlation of Baby's Health (First Visit) with Age.*

Age of Baby in Days	Boys				Totals	Girls				Totals
	Poor	Indifferent	Good	Very Good		Poor	Indifferent	Good	Very Good	
0— 20	5·5	10·5	87·5	8	111·5	4	12·5	78	7	101·5
20— 40	13	15·5	85·5	12	126	6	16	77	6	105
40— 60	17·5	24	97·5	13	152	12	16·5	99·5	10	138
60— 80	10·5	16	51	6	83·5	5·5	10	50·5	3	69
80—100	10·5	13	38	6·5	68	6·5	9	29	5·5	50
100—120	7	6	22	0·5	35·5	2	6	19·5	3·5	31
120—140	9	7	25	4	45	3	13	23·5	1	40·5
140—170	8	8·5	26·5	3	46	5	5	28	2	40
170—200	5	5·5	24	2	36·5	2	4	23	2	31
200—230	7	4	19	1	31	3	1	15	0	19
230—260	3	7	15·5	1	26·5	2	2	19·5	0	23·5
260—300	2	2·5	13	3	20·5	4	3	16	0	23
300—330	4	2·5	9·5	2·5	18·5	5	2	11·5	2	20·5
330—360	2	1	12	1·5	16·5	2	2	6	0	10
Totals ...	104	123	526	64	817	62	102	496	42	702
Mean Age at First Visit...	95·64 days					94·93 days				
Correlation Coefficient ...	$r = -\cdot 0864 \pm \cdot 0234$					$r = -\cdot 1326 \pm \cdot 0250$				
Correlation Ratio	$\eta = \cdot 1784 \pm \cdot 0229$					$\eta = \cdot 1710 \pm \cdot 0248$				

Correlation coefficients and ratios were found by considering health arrays for given age groups. The correlation coefficients are small, but as they differ somewhat from the correlation ratios we have fitted the regression curves with parabolas. These are, if σ_h denote the standard deviation of health, h be health measured from the mean of health and a be the age in days:

Boys ... $h/\sigma_h = \cdot 2817 - \cdot 005{,}745a + \cdot 0000{,}1639a^2$;
Girls ... $h/\sigma_h = \cdot 1724 - \cdot 002{,}533a + \cdot 0000{,}0418a^2$.

Now these results indicate that:

(i) in both girls and boys there is a slight fall in general health with age, marked by the negative correlations $-\cdot 09$ for boys and $-\cdot 13$ for girls;

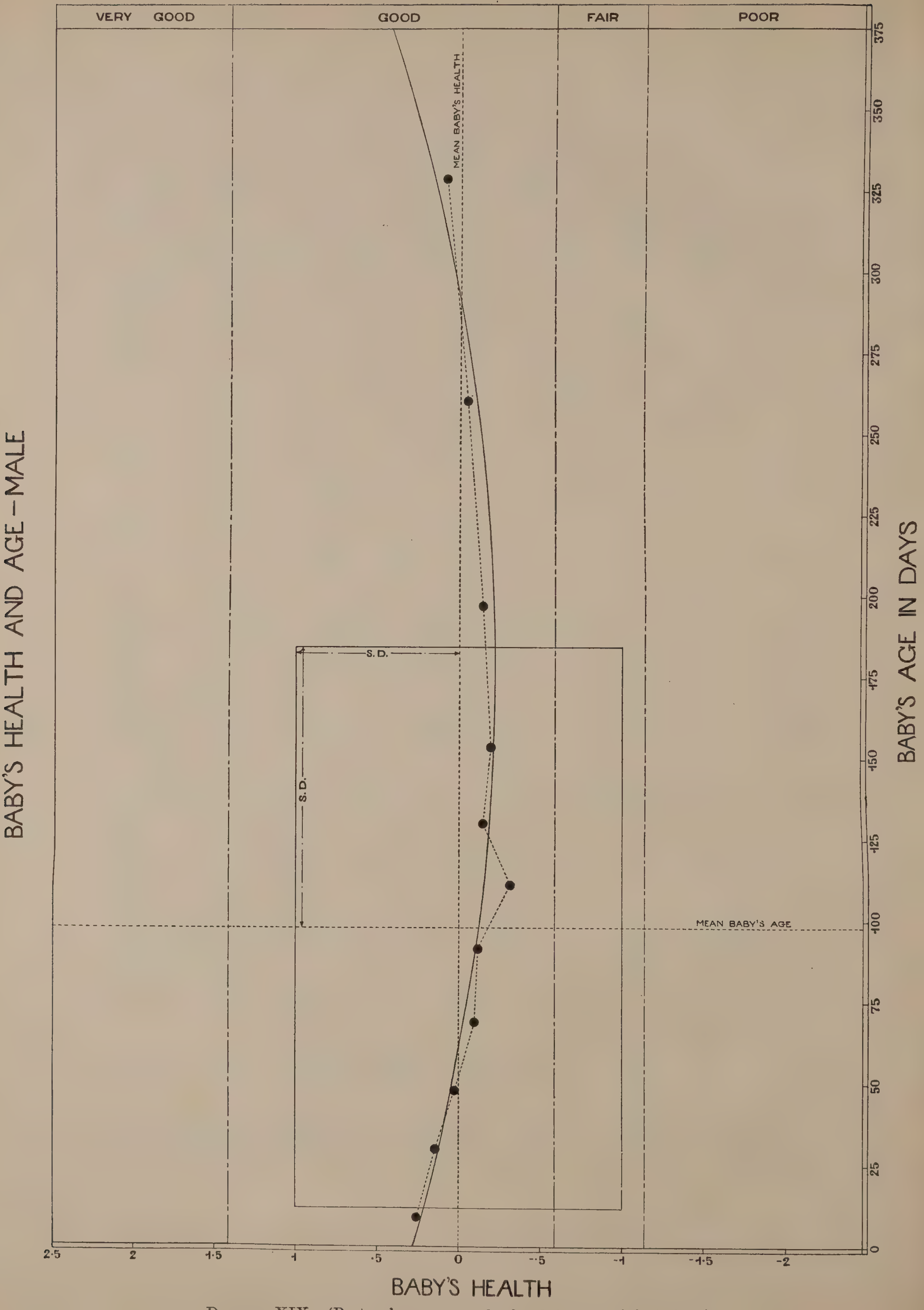

DIAGRAM XIX. (Rectangle represents the doubled standard deviations.)

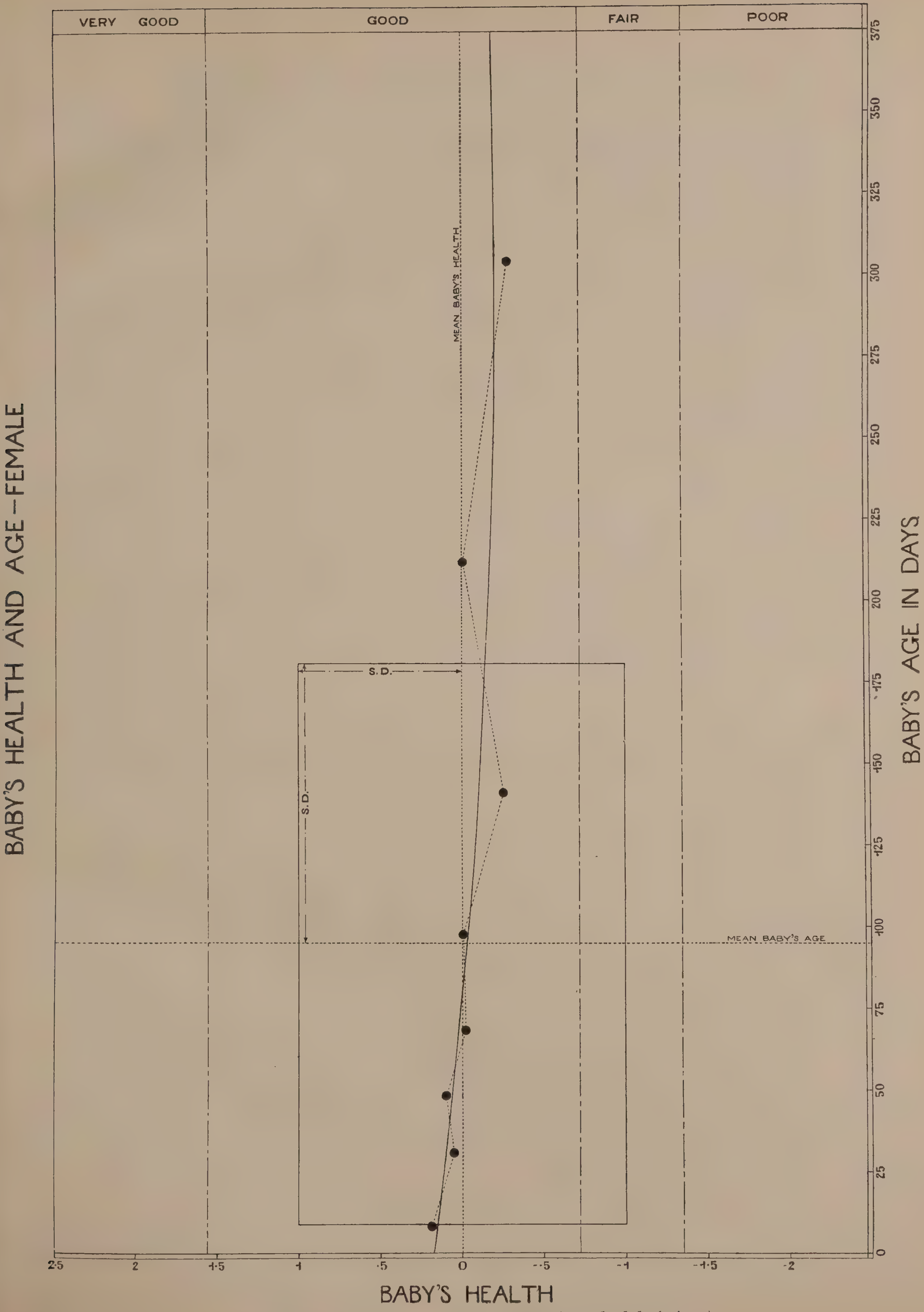

DIAGRAM XX. (Rectangle represents the doubled standard deviations.)

(ii) in both girls and boys the regression is not linear, but tends after a fall to rise again. This is the explanation of the larger values of the correlation ratios, and is indicated on the graphs. The rise begins earlier and is much quicker in boys than girls. The maximum fall is reached in boys at about 175 days and in girls at about 303 days, these numbers of course being very rough on our limited data: see Diagrams XIX and XX.

In boys the drop is to $-\cdot 2217\sigma_h$, or since the health at birth is $\cdot 2817\sigma_h$, there is a total drop from birth to 175 days of $\cdot 5034\sigma_h$. But the range of 'good health' in boys $= 2\cdot 0057\sigma_h$. Hence the total drop is about a quarter of the range of 'good health.' By the end of a year, however, if we can trust our parabolic regression, the health of the boy on the average is $\cdot 3684\sigma_h$ above the mean, while it was only $\cdot 2817\sigma_h$ above it at birth. Thus there is a rise of $\cdot 0867\sigma_h$ in health, or about $\frac{1}{23}$ of the range of 'good health.'

In girls the maximum fall in health below the mean is $-\cdot 2113\sigma_h$, or since the health at birth is $\cdot 1724\sigma_h$, a total drop of $\cdot 3837\sigma_h$ from birth to 303 days. The range of 'good health' is $2\cdot 2832\sigma_h$ or the drop is about $\frac{1}{6}$ of the total range of 'good health,' i.e. less than it is in boys. On the other hand, at the end of the year the girls are still $\cdot 3676\sigma_h$ below their health at birth, although the upward trend has become visible.

The decreasing health with age is, of course, not very marked, but it covers probably all the truth there is in the absurd statement often made that "All babies are born healthy"—the inference being drawn (or left to be drawn, as suits the propounder's immediate purpose), namely, that it is environment or handling after birth which makes them unhealthy.

When we analyse our data, however, it may be even doubtful whether this relatively small drop in health is a real one. Babies whose mothers do not come at an early stage to the clinic often come at a later stage because the baby is not thriving. When a baby is doing well its mother thinks less of seeking advice about it, and the result may well be that the less healthy babies are precisely those who come at a later age to the clinic. On the other hand, the later rise so marked in the boys, but less so in the girls, may be due to the deaths of the babies of worse health before the end of the twelve months.

There is another point also worthy of consideration. Two machines may appear equally good when new, but it is only after the wear and tear of use that we may be able to see that one was made of good metal and the other of poor. So it must almost certainly be with any organism; it is only after a test of its normal functioning that one can assert that it is physiologically sound. We should not expect a very high correlation between the appreciation of the health of a baby at birth, and its health after its organs have been tested by running for a twelvemonth. The judgment of the health of a baby at birth is a difficult matter, because the organs on which its postnatal health depends have not yet been adequately tested.

In order to measure the correlation between baby's health at birth and health at a year we must reduce baby's health at first visit to health at birth or we must correct for the interval between birth and first visit.

Actually we have the following correlations between health of baby and interval between first visit and date at which the 'health of baby at a year' was determined:

TABLE LIX.

Correlation between Interval and	Boys	Girls
Health of Baby at First Visit ...	$r = \cdot 0706 \pm \cdot 0234$	$r = \cdot 1121 \pm \cdot 0251$
Health of Baby at a Year ...	$r = -\cdot 0719 \pm \cdot 0239$	$r = -\cdot 0582 \pm \cdot 0256$

These values are relatively small and will not effect much change in the relationship of Baby's Health at First Visit and Baby's Health at the End of a Year.

The following contingency tables give the relation of the two infantile healths:

TABLE LX.

Baby's Health at First Visit	Baby's Health at end of First Year*											
	Boys					Totals	Girls					Totals
	I+II	III	IV	V	VI		I+II	III	IV	V	VI	
Very Good	25	22	7	5	6	65	21	9	3	4	4	41
Normal ...	154	202	45	60	42	503	128	214	39	53	41	475
Indifferent	19	35	19	23	21	117	15	28	14	19	18	94
Poor ...	16	22	12	29	29	108	7	14	8	23	25	77
Totals ...	214	281	83	117	98	793	171	265	64	99	88	687

The correlations found by mean square contingency and corrected for class-index correlations are:

Boys ... ·3612 Girls ... ·4383

If we now correct these for interval between first visit and date of 'Health at End of Year,' we find for the partial correlations between the healths for constant interval:

Boys ... ·3682 Girls ... ·4484

or we get no substantial modification.

Diagrams XXI and XXII show the relation between the Health at a Year and Health at First Visit. It is clearly not linear, and in these diagrams we have represented the relation by a parabola. Since we have already seen that the correlation ratios for 'Interval' and 'Health of Baby at First Visit' differ considerably from the correlation coefficients—and the same remark applies to the correlation ratios of Interval and 'Health at End of Year'—we controlled the above figures by reducing on the basis

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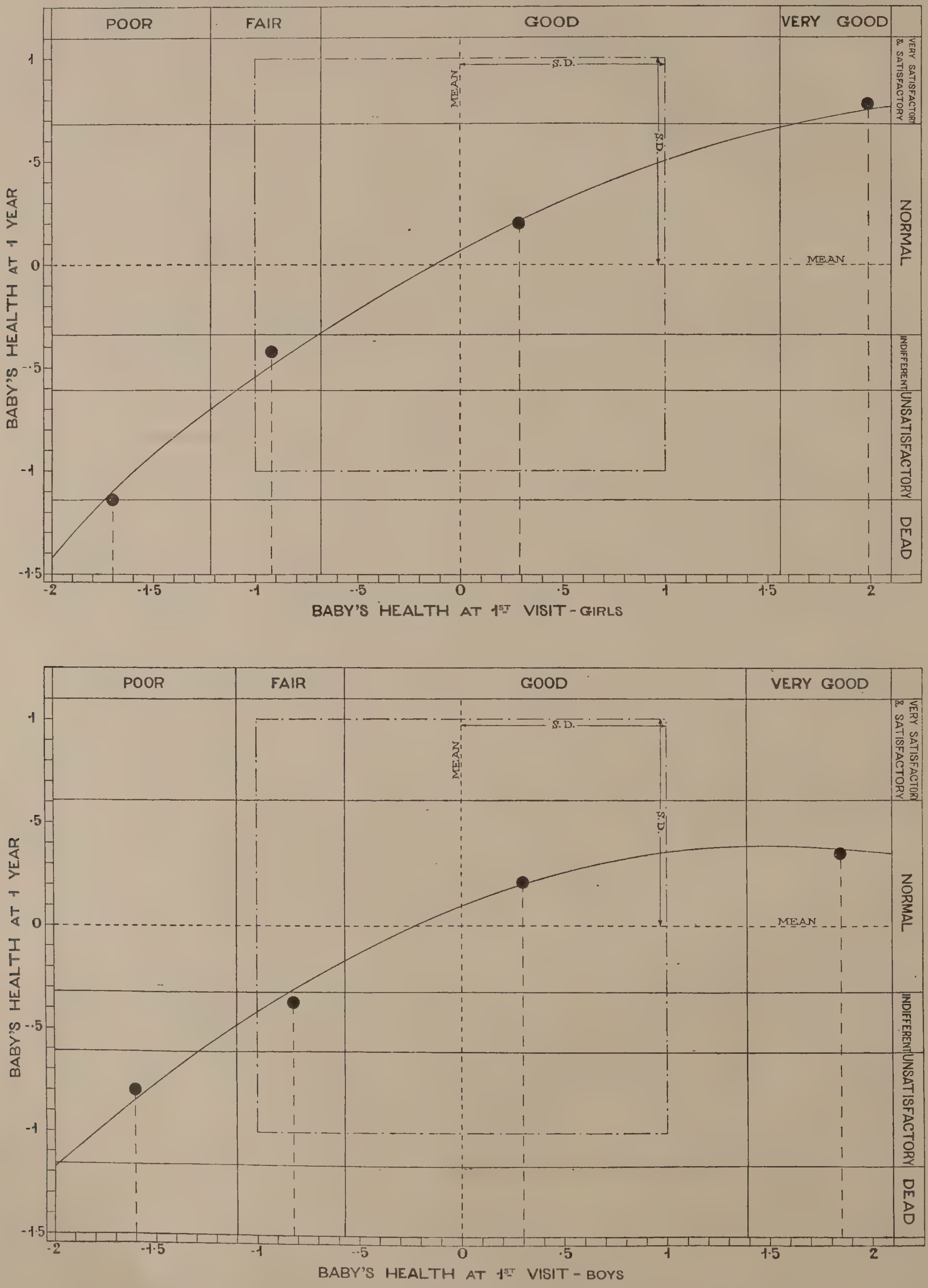
* As before the Health Classes are: I, Very Satisfactory; II, Satisfactory; III, Normal; IV, Indifferent; V, Unsatisfactory; VI, Dead.



Diagrams XXI and XXII. (Rectangles represent the doubled standard deviations.)

of our curved regression lines (see Diagrams XIX and XX) each individual 'Health at First Visit' to 'Health at Birth.' These theoretical 'Healths at Birth' were added to the schedules and on resorting changed the distribution in certain of the categories.

TABLE LXI.

Theoretical Health at Birth	Baby's Health at End of Year											
	Boys					Totals	Girls					Totals
	I+II	III	IV	V	VI		I+II	III	IV	V	VI	
Very Good	25	22	7	5	6	65	21	9	3	4	4	41
Normal ...	168	229·5	57	76	52	582·5	132	221	44	59	46	502
Indifferent	8	9·5	8	10	14	49·5	11	21	9	13	13	67
Poor ...	13	20	11	26	26	96	7	14	8	23	25	77
Totals ...	214	281	83	117	98	793	171	265	64	99	88	687

The correlations as found by mean square contingency corrected for class-index correlations are:

Boys ... ·3720 Girls ... ·4287

In other words, the relationship for the boys has been very slightly increased and for the girls slightly decreased. But no essential change is made by this method of approaching the problem. We conclude that there is a considerable but not intensive correlation between infant health in early weeks and health at a year, or if the reader prefer between the estimates of health at these periods. The relationship is nothing like as close as it is in the adult at different times. It is more of the order of adult fraternal healths. Thus while Health at Birth is helpful, it is not feasible to predict closely from it what will be the health at the end of a year.

Those who take the view that "all babies are born healthy" will no doubt continue to believe that the want of high correlation between health at birth and health at a year is due to differential environment and differential treatment. To that argument a threefold reply may be given:

(*a*) that a baby is a new machine and that the efficiency of its physiological functioning can only be tested by experience;

(*b*) that the particular factors of environment which *largely* influence infant health have yet to be demonstrated;

(*c*) that our data appear to indicate that 18·3 °/o of male and 21·0 °/o of female babies were actually in 'indifferent' or 'poor' health at or very near birth.

One of the grave disadvantages of this want of stability in the estimates of baby's health during the first twelve months is that it renders largely ineffectual any attempt to measure the hereditary-factor in infantile health. Further the individual's health at a year is not the adult health, and what we want to correlate is the health of the parents when they were one year old with the health of baby at one year—information which is not forthcoming in data of the present character, and will only be forthcoming in any material when the habit of forming accurate family histories is more widely spread and more persistent than at present.

(*a*) *Influence of Cleanliness of Home.* We have already seen that orderliness of the home is comparatively highly correlated with cleanliness of the baby, and have suggested that both are merely indices to the habits of mother. We have unfortunately not very ample data for home conditions and health of baby at a year, so that we have been obliged to throw both sexes together to get adequate numbers. We thus obtained the following table:

TABLE LXII. *Baby's Health (♂+♀) and Home Conditions.*

Home Conditions	Baby's Health at a Year					
	I+II	III	IV	V	VI	Totals
Good ...	91	96	22	38	18	265
Fair ...	30	25	11	21	11	98
Bad ...	29	47	20	32	13	141
Totals ...	150	168	53	91	42	504

If we treat the arrays of baby's health for given home conditions as normal in order to find their means and correct for the class-index of home conditions we have:

$$r = \cdot 1682 \pm \cdot 0292.$$

The regression line is shown in Diagram XXIII. There is quite a good linear relation between health of baby at a year and home conditions*. But the total transition from good to bad homes still leaves the average baby in 'normal' health. If we treat the range of normal health in babies as consisting of a hundred units of health†, then the rise in scale of health from 'Death' to 'Very Satisfactory' is 415 sanitaces; the influence of home conditions has an average range of 40 sanitaces. In other words, it does not suffice to remove a baby in average normal health from the category of normal health. It would suffice, however, to carry a baby already with the mean of poor health, i.e. 91 sanitaces below the health of the average baby, to 91 + 40 = 131 sanitaces below mean health, i.e. to some 9 units below the health (122 below the mean) at which life on the average ceases to be possible.

It will be seen by comparison with pp. 42–3 that cleanliness and orderliness of home appear somewhat more influential than cleanliness of baby itself, but of course something of this excess may be due to our pooling boys and girls. In order to test this we correlated weights at a year (49 to 55 weeks) with condition of home, keeping the sexes separate.

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* Shown by hollow circles.

† 'Sanitaces': see *Biometrika*, Vol. IX, p. 321. The number of units corresponding to each grade are here based on the mean results of the scales on p. 4 for male and female infants.

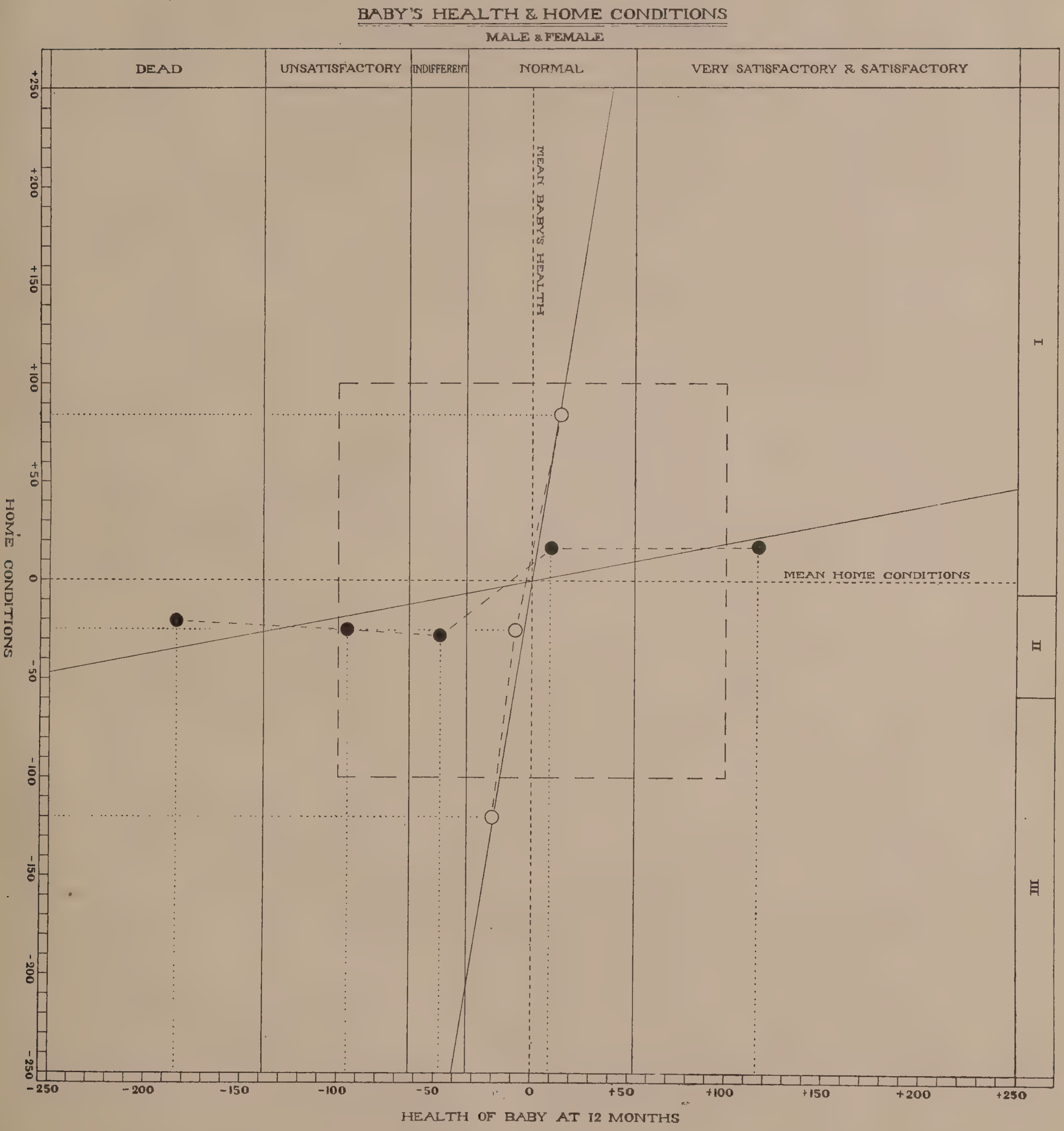

DIAGRAM XXIII. (Rectangle represents the doubled standard deviations.)

Table LXIII. *Weight of Baby at a Year and Home Conditions.*

Weight at Year in lbs.	Boys				Girls			
	Good	Fair	Poor	Totals	Good	Fair	Poor	Totals
* 10—	1	—	—	1	2	—	4	6
11—	—	—	—	—	1	6	1	8
12—	4	—	2	6	3	—	—	3
13—	4	—	2	6	3	—	—	3
14—	3	5	4	12	2	—	—	2
15—	5	1	3	9	9	2	1	12
16—	5	3	1	9	9	8	12	29
17—	17	2	1	20	11	6	9	26
18—	14	1	1	16	14	9	—	23
19—	9	4	5	18	13	1	2	16
20—	9	4	—	13	10	—	2	12
21—	11	8	1	20	1	6	—	7
22—	9	3	1	13	4	6	—	10
23—	4	6	—	10	—	—	—	—
24—	—	—	3	3	—	—	—	—
25—	—	—	1	1	—	—	—	—
Totals ...	95	37	25	157	82	44	31	157

The material is still more slender than in the case of health at a year. Working with arrays of weights for given home conditions we find for the mean weights:

Table LXIV.

Home Conditions	Boys	Girls
Good	18·57 lbs.	17·64 lbs.
Fair	19·74 lbs.	17·86 lbs.
Bad	17·95 lbs.	16·24 lbs.
All Categories ...	18·75 lbs.	17·42 lbs.

We see that there is about 1·7 lbs. improvement as we pass from the bad homes to the fair homes, but that the good homes have babies of lighter weight than the fair homes. This may be due to random sampling, considering the smallness of the frequencies†, but it is to be observed that it holds for both sexes.

The result of course reflects itself in the deviations between η and r (worked for the vertical arrays of the tables and corrected for class-index of home conditions). We have:

Table LXV.

Boys	Girls
$r = \cdot 1003 \pm \cdot 0533$	$r = \cdot 1432 \pm \cdot 0527$
$\eta = \cdot 2220 \pm \cdot 0511$	$\eta = \cdot 2347 \pm \cdot 0508$

---

* See footnote, p. 32.

† The probable error of the 'Fair' means is of the order 0·3 lb.

As usual we see the girls more susceptible to environment than the boys. The correlation is, however, reduced, so that the relation between health and home conditions may have been exaggerated by pooling the sexes.

(*b*) *Baby's Health and Crowding of Home.* When we come to the problem of crowding we meet with very special difficulties. Crowding arises from two sources:

(i) *Poverty.* This means unemployment or low wage of father, or possibly drinking of either or both parents. Unemployment and low wage usually arise from bad health, and if not they as well as drink are connected with bad parental habits. In such cases any association of crowding with health of baby may be only an indirect measure of the far more important associations of health of baby with health and habits of parents.

(ii) *Size of family.* Wages do not advance proportionately with size of family, and if the home has increased from two to four rooms, say, this is all that is feasible till the children begin by their own labour to increase the family income. There is a most substantial association between crowding and the number of living children.

Again Father's Wage is fairly closely correlated with rent, and it is hardly at all correlated with size of family, and what correlation exists is *negative.* All these points must be considered in the matter of crowding; but as far as crowding is due to size of family that in itself connotes less income per head and greater age of the mother. There are associations between age of mother at birth and her health and the baby's health.

There is also a correlation between baby's health and its place in the family. The problem therefore of the *direct* influence of crowding on baby's health is by no means a simple one. It may be that association of crowding and baby's health is merely an index of other causative factors which lead to crowding and bad health in baby. Let us make an hypothesis—which however does *not* represent the facts, but will explain how cautious one ought to be. Suppose baby's bad health were largely a product of father's bad health*; now father's bad health leads to low wage or unemployment, and these to low rent, and ultimately to crowding. Then the association of health and crowding would not be direct, but traceable to the really causative factor, father's health. If it be said that the relatively small association of crowding and baby's health, which we shall show to exist, must show something wrong with the data, we would ask the reader for a moment to reflect on the evolutionary history of man. He has by no means a purely arboreal past! We have to think of him surviving glacial and interglacial epochs, and picture the crowding and ventilation conditions of caves with a fire within the entrance, or of Esquimo snow dwellings and of hut circles. Man has been specialised to stand pretty bad ventilation: it is other factors of modern civilisation which affect his health, factors which he is not yet adapted to meet, as the wild man at present is not specialised to meet measles, tuberculosis, or the white man's alcohol.

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* This as we shall see is not so; there is little correlation between father's health and baby's health until the latter reaches the adult stage.

It is well to investigate some of these points before we turn to the relation of crowding to baby's health. We give first in a somewhat condensed form the table connecting the number of living children with the number of persons per room. The latter has been determined in the following way: A sitting-room, bedroom or attic was counted as one room, a scullery or cellar as half a room. As we did not know the ages of persons living in the house, each person was counted as a unit, so that comparatively young children had to be reckoned precisely the same as adults.

TABLE LXVI.

Number of Persons per Room	Number of Living Children														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Totals
·3 and ·4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
·5 „ ·6	38	1	—	—	—	—	—	—	—	—	—	—	—	—	39
·7 „ ·8	115	36	1	—	—	—	—	—	—	—	—	—	—	—	152
·9 „ 1·0	184	51	16	2	—	—	—	—	—	—	—	—	—	—	253
1·1 „ 1·2	163·5	106	33·5	15	1	1	1·5	—	—	—	—	—	—	—	321·5
1·3 „ 1·4	11·5	78	90·5	14	7	2	1·5	—	1	—	—	—	—	—	205·5
1·5 „ 1·6	92	104	14	15	15	8	2	—	1	—	—	—	—	—	251
1·7 „ 1·8	7	6	47	45	15	7	6	3	1	—	—	—	—	—	137
1·9 „ 2·0	9	64	59	44	42	15	13	4	1	1	—	—	—	—	252
2·1 „ 2·2	1	—	—	—	—	1	3	3	2	1	—	—	—	—	11
2·3 „ 2·4	4	1	1	42	24	25	4	—	—	3	1	—	—	—	105
2·5 „ 2·6	1	4	50	2	—	—	5	3	—	—	—	—	—	—	65
2·7 „ 2·8	—	2	—	1	26	10	1	1	1	—	—	—	—	—	42
2·9 „ 3·0	—	—	—	15	1	—	7	3	—	—	—	—	—	—	26
3·1 „ 3·2	—	—	—	—	2	13	1	—	4	—	—	—	—	1	21
3·3 „ 3·4	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2
3·5 „ 3·6	—	—	—	2	11	—	—	1	—	—	—	—	—	—	14
3·7 „ 3·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
3·9 „ 4·0	—	2	—	—	—	3	—	—	—	—	—	—	—	—	5
Totals ...	627	455	312	197	144	85	45	19	12	5	1	—	—	1	1903
Means ...	1·07	1·38	1·69	1·95	2·23	2·34	2·20	2·42	2·49	2·43					1·535

We have for the correlation coefficient: $r = \cdot 6768 \pm \cdot 0084$ and for the correlation ratio from vertical arrays: $\eta = \cdot 7048 \pm \cdot 0078$, showing how closely dependent crowding is on the size of the family.

Diagram XXIV shows the nature of the relationship; crowding increases at a nearly perfectly uniform rate until five or six children have been born—this seems to indicate that the parents remain practically in the same-sized house. But the eldest child by the time the sixth or seventh baby is born is now 13 to 14 years of age*. The eldest now starts earning and the parents can afford a larger house. Crowding practically ceases to increase as successive children reach the earning stage and contribute to the family income. It might be imagined that the cessation of crowding was due to the children leaving home; inquiries seem to show that they do not leave home at an early age in this district*.

---

* The average interval between births is 2·6 years, the average age of mother at marriage 19·7 years in the rather low type working-class population (average wage 25*s.* before war) we are dealing with.

The betterment of housing seems to come at the time when the children begin to

CROWDING AND NUMBER OF LIVING CHILDREN

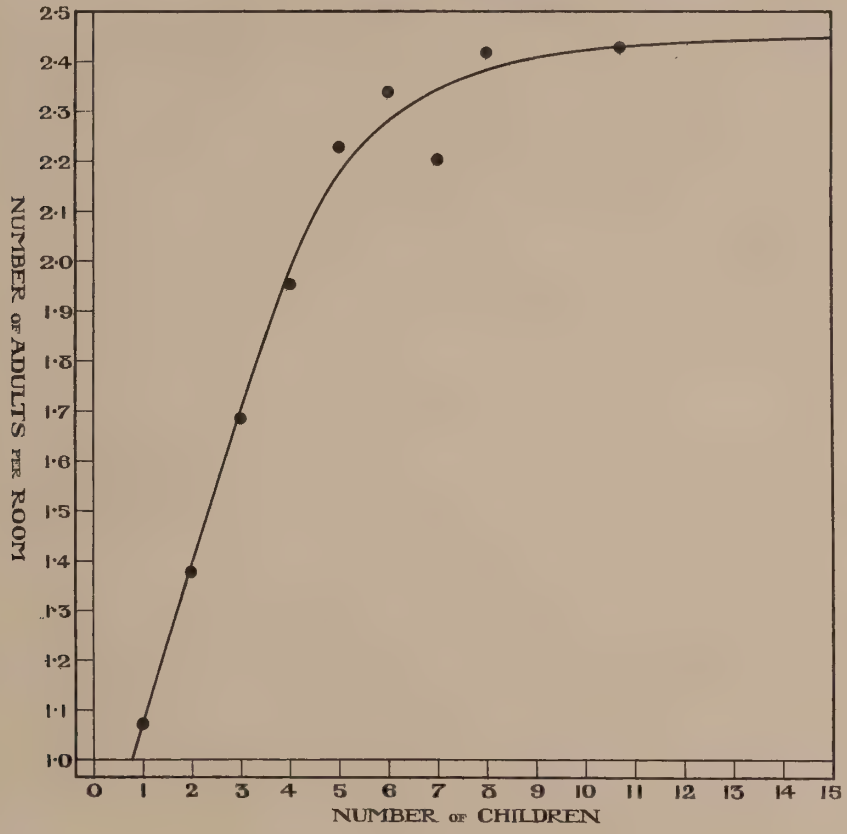

DIAGRAM XXIV.

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* In 1894 families examined there were only 190 children of 15 and over, and 17 alone of these had left home. The stopping down of the crowding can thus hardly be due to children leaving home, but to children beginning to earn and a larger rent being thus possible. Thus we have:

Mean number of rooms for families with all children under 15 years	3·29
Mean number of rooms for families with *some* children 15 years and over ...	3·96

Again we formed the following table:

Ratio of number of children 15 years and over to all children at home	Number of Rooms
0·1	4·50
0·2	3·93
0·3	3·81
0·4	4·09
0·5 and 0·6	3·65
0·7, 0·8, 0·9 and 1·0 ...	4·27

Thus while the proportion of children over 15 increases, there is not a proportional increase in the number of rooms. There is one change when possible from a 3 or 4 roomed house to a 4 or 5 roomed house, but not a continuous ascent as more and more children earn.

earn. In the district we are studying the tenements for working-class families are constructed on three patterns: (i) Living room, sleeping room and a scullery or cellar = 2·5 rooms on our scale; (ii) an additional sleeping room = 3·5 rooms; (iii) living room, two sleeping rooms, an attic and a scullery or cellar = 4·5 rooms. The uniform increase of crowding with number of living children is produced by the bulk of parents living in houses of 2·5 rooms until the elder children reach earning age, when they pass to a 3·5 roomed or, less frequently, to a 4·5 roomed house. Of course the table is thus rendered, as it obviously is, heterogeneous, and the problem is complicated by the presence of other relatives of the family or of lodgers. Clearly, however, one of the main factors of crowding is the size of family.

Let us now investigate to what extent Father's Wage is related to (i) crowding and (ii) size of family.

We have the table on the opposite page for Father's Wage and Number of Persons per Room.

We find for the correlation:

$$r = -\cdot 2095 \pm \cdot 0240.$$

There is thus a sensible, but not very intense, correlation between Father's Wage and Persons per Room—a low wage being associated with overcrowding. The means at the foot of the table give the general change in crowding with wage. The equation to the regression line is, if p = average number of persons per room for wage w in shillings:

$$p = 1\cdot 709 - \cdot 007{,}773\, w.$$

Hence, the mean number of persons per room being 1·52, we see that the mean number of persons per room when the father is in receipt of no wage is 1·71 and when he earns 50*s.* a week is 1·32, or the whole range of the workman's wages does not make an average change of more than ·4, i.e. less than half a person difference in the crowding rate. It is clear that while wages do exercise some influence, they are not—within the range of pre-war payment—the essential factor in crowding: see Diagram XXV.

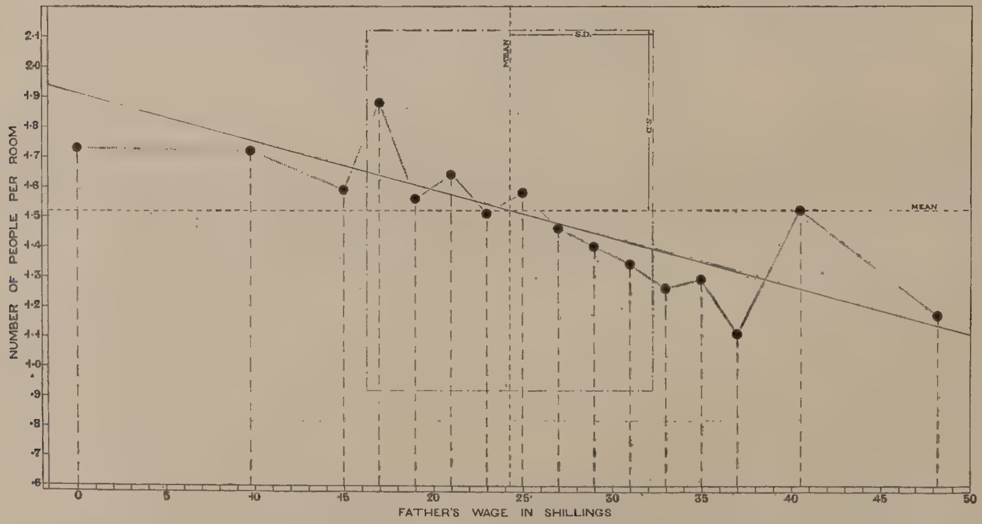

Diagram XXV. (Rectangle represents the doubled standard deviations.)

TABLE LXVII.

Number of Persons per Room	Father's Wage in Shillings																													Totals
	Below 2	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	
·4 and ·5	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	3
·6 ,, ·7	2	—	—	—	—	—	—	1	—	1	3·5	2	5·5	3	1·5	5	4	2	7·5	—	1	—	1	—	—	1	—	—	—	41
·8 ,, ·9	1	—	—	—	—	—	1	1	—	4	9·5	6	12·5	7	7·5	12	2	4	4·5	—	4	—	—	—	—	—	—	—	1	77
1·0 ,, 1·1	2	1	—	—	—	—	—	2	2	8	14	17	13	4	8	17	3	5	5	—	2	—	1	—	—	—	—	—	—	104
1·2 ,, 1·3	3	—	—	—	—	1	2	4	2	10	30	16	10	8	4	5	2	3	4	—	2	—	1	—	—	1	—	—	—	108
1·4 ,, 1·5	5	—	—	—	—	—	—	3	2	7	23	6	17	7	4	12	—	2	—	1	2	—	—	—	—	—	—	—	—	91
1·6 ,, 1·7	6	—	—	—	1	1	1	3	1	5	24	7·5	19	7	5	5	4	3·5	3	—	—	—	—	—	—	—	—	—	—	96
1·8 ,, 1·9	—	—	—	—	—	—	—	—	1	1	—	1·5	—	1	1	—	—	·5	—	—	1	—	—	—	—	—	—	—	—	7
2·0 ,, 2·1	5	—	1	—	2	—	1	2	5	9	10	21	13	5	3	10	2	2	1	1	1	—	—	—	—	—	—	—	—	94
2·2 ,, 2·3	—	—	—	—	—	—	—	1	—	—	8	3	4	3	1	2	1	1	—	1	—	—	—	—	—	—	—	—	—	25
2·4 ,, 2·5	4	—	—	—	—	—	—	2	2	2	10	2	9	—	1	1	—	—	1	1	1	1	—	—	—	—	—	—	—	37
2·6 ,, 2·7	—	—	—	—	—	—	—	—	—	2	3	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	7
2·8 ,, 2·9	—	—	—	—	—	—	—	1	1	1	1	—	2	1	2	—	—	—	—	1	—	—	—	—	—	—	—	—	—	10
3·0 ,, 3·1	—	—	—	—	—	—	—	—	—	1	4	—	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
3·2 ,, 3·3	1	—	—	—	—	—	—	—	1	1	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
3·4 ,, 3·5	1	—	1	—	—	—	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
3·6 ,, 3·7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3·8 ,, 3·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4·0 ,, 4·1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	30	1	2	0	3	2	5	20	17	53	147	83	109	47	38	72	18	23	26	5	14	1	3	0	0	2	0	0	1	722
Means	1·73	1·72						1·59	1·88	1·56	1·64	1·51	1·58	1·46	1·40	1·34	1·26	1·29	1·11	1·52		1·17								1·52

We may pursue this matter a little further and ask what is the correlation between Father's Wage w and Rent R? Dealing with somewhat over 600 cases in which both were known to us we found $r = {\cdot}4586 \pm {\cdot}0217$, or more than double the relation between father's wage and crowding. The regression equation is

$$R = 2{\cdot}586 + {\cdot}059{,}483\, w.$$

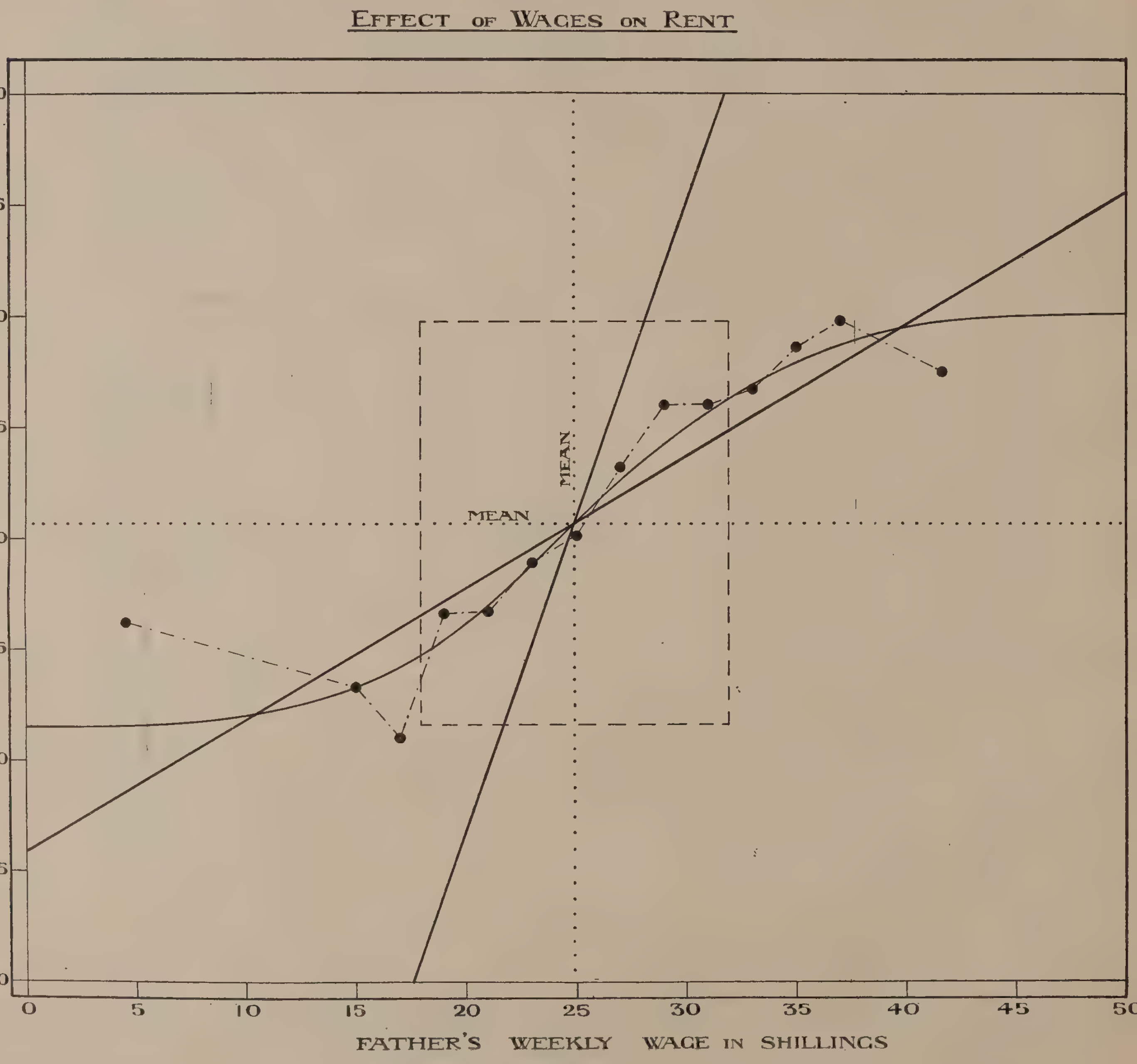

Diagram XXVI. (Rectangle represents the doubled standard deviations.)

Hence, the mean rent being 4·068*s.* a week, the man with no wages pays 2·59*s.* and the man with 50*s.* per week pays 5·56*s.* Actually our group with lowest wages, those under 14*s.*, paid on the average 3·62*s.* and our group with the highest wages, i.e. those over 40*s.*, paid 4·75*s.* as rent[*]. In other words, 26*s.* additional wage does not mean more than 1*s.* to 1*s.* 6*d.* extra in rent, and this is not such a difference in rent that it would have a large influence on the crowding, even if the man with the highest wage had the biggest family[†]. To this question we now turn: What is the association between wage and size of family? The following table gives our data, and we now discover that there is hardly any relation between the two, and what exists is *negative*, or the higher the wage the fewer the children:

TABLE LXVIII.

Father's Wage in Shillings	Number of Children																Totals	Means
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
Under 20	19	23	8	7	7	4	5	3	1	—	—	—	—	1	—	—	78	3·31
20—25	58	53	46	37	28	21	11	8	9	2	—	—	—	—	—	—	273	3·51
25—31	36	25	16	16	6	5	9	3	1	1	—	—	1	—	—	—	119	3·17
Over 31	28	17	4	5	5	4	4	5	1	2	1	—	—	—	—	—	76	3·30
Totals ...	141	118	74	65	46	34	29	19	12	5	1	—	1	1	—	—	546	3·38

The material is somewhat slender, but it suffices to show that the number of children is in no wise proportional to the size of wage. The actual correlation is – ·0634 ± ·0288, a result barely significant, but confirming the more ample data of previous investigations that the higher the wage the smaller the family[‡]. The regression line (based on a more complete table) is:

$$\text{Number of children} = 3\cdot83 - \cdot018{,}687 \times \text{Wage},$$

giving for adjusted values:

TABLE LXIX.

Wage in Shillings ...	0	5	10	15	20	25	30	35	40	45	50
Mean No. of Children ...	3·83	3·74	3·64	3·55	3·46	3·36	3·27	3·18	3·08	2·99	2·90

Thus between the lowest and highest wages of our clinic population there is less than one child drop. Of course the data refer to incomplete families. There is clearly no correspondence between wage and size of family, and the result is that the chief factor of crowding is the increase in size of the family. There are probably two causes at work: (i) a tendency for wages to rise somewhat in the early years of a man's life, and (ii) a tendency of the more highly skilled and therefore better paid workmen to limit their families; the latter cause on the whole predominating. We have not adequate information in the present material to separate out these two causes.

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[*] Actually the regression is skew, see Diagram XXVI, the rent paid ceasing to decrease with decreasing wage, and ceasing to increase with increasing wage as is indicated by the cubic regression curve. We give both regression straight-lines as well.

[†] A shilling or at most eighteenpence a week will not provide the additional accommodation requisite when a family increases from 3 to 10 members.

[‡] See *Eugenics Laboratory Memoirs*, XVIII. On the Correlation of Fertility with Social Value. Cambridge University Press.

What is clear, however, is that, while crowding depends to a certain extent on wage, it is mainly due to the increasing size of family in the first 12 years of married life, without any adequate increase in the wage earned. If, as seems to flow from our results, there is a check to crowding as the children begin at 13 or soon after to earn, then this point ought to be seriously taken into consideration by those who wish to keep the children two or three years longer at school.

Before we turn to the main object of inquiry in this section—Crowding and Health of Baby—it is of interest to investigate the association of the health of the adult parents with crowding. The following tables give the association of parental health with crowding:

TABLE LXX.

Father's Health	Number of People per Room																			Totals
	·3—·4	·5—·6	·7—·8	·9—1·0	1·1—1·2	1·3—1·4	1·5—1·6	1·7—1·8	1·9—2·0	2·1—2·2	2·3—2·4	2·5—2·6	2·7—2·8	2·9—3·0	3·1—3·2	3·3—3·4	3·5—3·6	3·7—3·8	3·9—4·0	
Good ...	1	21	58	102	143·5	69·5	89	47	76	4	37	16	15	12	8	2	7	—	3	711
Fair	—	1	2	9	8	6	2	1	9	1	—	3	2	—	1	—	—	—	—	45
Poor	—	—	3	3	14·5	4·5	8	2	9	—	4	5	1	3	—	—	1	—	—	58
Dead ...	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	—	—	3
Totals ...	1	22	63	114	166	80	99	51	95	5	42	24	18	15	9	2	8	—	3	817

Mother's Health	Number of People per Room																			Totals
	·3—·4	·5—·6	·7—·8	·9—1·0	1·1—1·2	1·3—1·4	1·5—1·6	1·7—1·8	1·9—2·0	2·1—2·2	2·3—2·4	2·5—2·6	2·7—2·8	2·9—3·0	3·1—3·2	3·3—3·4	3·5—3·6	3·7—3·8	3·9—4·0	
Good ...	1	24	83	140	176	105	140	67	134	9	63	37	28	18	11	2	5	—	3	1046
Fair ...	—	6	10	20	44·5	18·5	24	16	32	0·5	13·5	5	4	4	3	—	3	—	—	204
Poor ...	—	2	5	15	17·5	12·5	11	6	11	—	2	3	3	2	3	—	3	—	—	96
Totals ...	1	32	98	175	238	136	175	89	177	9·5	78·5	45	35	24	17	2	11	—	3	1346

The most satisfactory method of determining the correlation here appears to be 'biserial *r*,' the dichotomic lines separating 'Good' from lower grades of health[*]. These give:

Father's Health and Number of People per Room ...	−·1214 ± ·0233
Mother's ,, ,, ,, ,, ...	−·0342 ± ·0184

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[*] The less satisfactory method of taking means for horizontal arrays and supposing the vertical margin numeral leads after correction for class-index of health to −·1351 for Father's and −·0395 for Mother's Health, sensibly identical values.

It is clear from these results that the association of Mother's Health and Crowding is not significant on the basis of our data, but that it is significant, but of no great intensity in the case of the father. We can exhibit this to the non-statistically minded reader by Diagram XXVII or by simply taking the means of the arrays of crowding:

TABLE LXXI.

Father's Health	Persons per Room	Mother's Health	Persons per Room
Good	1·498	Good	1·546
Fair	1·547	Fair	1·587
Poor and Dead	1·718	Poor	1·579
All Categories	1·517	All Categories	1·555

Now can we explain this result? The Father is away from the crowded home a large part of the day, and the Mother is there a large part of the day. The evil of crowding ought to tell more upon the individual who is mostly in the home. The greater association of the Father's Health than the Mother's Health with Home Conditions has occurred in other investigations undertaken in this Laboratory. It has also been noted in certain recent investigations undertaken for the Ministry of Health on the relation of tuberculosis in certain trades to home and factory conditions*. In those investigations it was found that there was no criticism to be made of the factory condition, but that there was an association between the bad health of the workman and home conditions which could not likewise be traced in the health of his wife.

The suggestion put forward was that the Wife by her continuous presence in the home grew immune to its injurious effects, but that the Husband spending the greater proportion of his time in a well ventilated factory was open to the deleterious influence of a crowded home and succumbed, where the Wife had been rendered impervious to its attacks. Such a suggestion, if correct, might seem an argument for a return to the early nineteenth century system of home industry! We believe it, however, to be incorrect, and that there is a more direct explanation of the association of Home Crowding with Father's Health. Any bad health of the Father, including of course phthisis, means lessened or even total loss of wage; this involves a reduction in the rent that can be paid, and consequently a smaller or poorer type of home. It is not the health following the home, but the home following the health. There are, related to other correlations we have been dealing with, very considerable correlations between Father's Health and his Wage and the Rent paid.

We now turn to the tables correlating Baby's Health at a Year and Number of Persons per Room. They are:

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* Collis and Greenwood, *The Health of the Industrial Worker*, London, 1921, p. 136.

TABLE LXXII.

Baby's Health at a year	Number of Persons per Room. Boys																			Totals
	·3—·4	·5—·6	·7—·8	·9—1·0	1·1—1·2	1·3—1·4	1·5—1·6	1·7—1·8	1·9—2·0	2·1—2·2	2·3—2·4	2·5—2·6	2·7—2·8	2·9—3·0	3·1—3·2	3·3—3·4	3·5—3·6	3·7—3·8	3·9—4·0	
I Very Good ...	—	1	3	4	4	8	5	2	4	—	2	—	—	—	—	—	—	—	—	33
II Good and Sat.	—	9	19	27	36·5	24·5	30	14	25	3	6	7	5	2	1	—	—	—	—	209
III Well and Thriv.	1	4	21	50	45	29	43	22	33	1	13	10	5	4	2	—	3	—	1	287
IV Fair	—	1	4	13	11·5	11·5	10	5	14	1	6	—	—	3	2	—	1	—	—	83
V Poor	—	—	12	8	23	19	14	13	17	—	8	7	6	1	2	—	1	—	—	131
VI Dead	—	3	5	11	16·5	7·5	16	6	15	—	4	6	3	1	—	1	1	—	—	96
Totals ...	1	18	64	113	136·5	99·5	118	62	108	5	39	30	19	11	7	1	6	—	1	839

Baby's Health at a year	Number of Persons per Room. Girls																			Totals
	·3—·4	·5—·6	·7—·8	·9—1·0	1·1—1·2	1·3—1·4	1·5—1·6	1·7—1·8	1·9—2·0	2·1—2·2	2·3—2·4	2·5—2·6	2·7—2·8	2·9—3·0	3·1—3·2	3·3—3·4	3·5—3·6	3·7—3·8	3·9—4·0	
I Very Good ...	—	—	1	5	4	4	1	—	2	—	—	—	—	—	—	—	—	—	—	17
II Good and Sat.	—	3	16	17	27·5	17·5	28	15	23	2·5	11·5	4	4	3	—	—	2	—	1	175
III Well and Thriv.	—	10	32	42	49	26	33	17	32	1·5	10·5	8	5	4	6	1	1	—	—	278
IV Fair	—	4	5	6	10·5	7·5	8	6	10	—	7	3	1	3	1	—	2	—	1	75
V Poor	—	1	2	5	17	12	13	9	19	—	13	3	2	3	2	—	2	—	—	103
VI Dead	—	—	3	9	12·5	10·5	15	5	12	—	7	5	1	—	1	—	1	—	—	82
Totals ...	—	18	59	84	120·5	77·5	98	52	98	4	49	23	13	13	10	1	8	—	2	730

The means of the horizontal arrays may be found and these taken at the means of baby's health categories arranged on a normal scale and thus the correlation found. Or, the vertical arrays may be treated as normal distributions with Group III as the central group and the means of these arrays found; the horizontal coordinate being already quantitative, the correlation can be found. See Diagram XXVII. If these correlations be respectively r_1 and r_2 we find:

$$\begin{array}{lll} \text{Boys} & \text{Mean} & \text{Girls} \quad\quad \text{Mean} \\ \left.\begin{array}{l} r_1 = -\cdot 1088 \\ r_2 = -\cdot 1229 \end{array}\right\} & -\cdot 1158 \pm \cdot 0230 & \left.\begin{array}{l} -\cdot 1134 \\ -\cdot 1463 \end{array}\right\} -\cdot 1298 \pm \cdot 0246 \end{array}$$

It appears therefore that the influence of crowding on Baby's Health at a Year is of the same order as its influence on the Father's Health. Supposing that Crowding really does influence Baby's Health, then it would take 5 extra persons per room beyond the average 1·56 persons to lower a baby of mean health beyond the limit at which health is not compatible with survival, i.e. 6·56 persons per room. 4·0 persons per room was, however, the maximum number recorded and this occurred only in two cases. Allowing therefore the correlation to mark a causation we do not consider it has much influence on the general health of baby. But we doubt whether we are really dealing with a causative association*. Crowding is very possibly only an index to general economic conditions of the home, and to these we shall now turn.

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* The reader must remember that Crowding is highly correlated with the number of living children and the correlation between Baby's Health and number of previous pregnancies is – ·13 for boys, practically the same as between Baby's Health and Crowding. Thus the latter may really only represent the effect of order of birth!

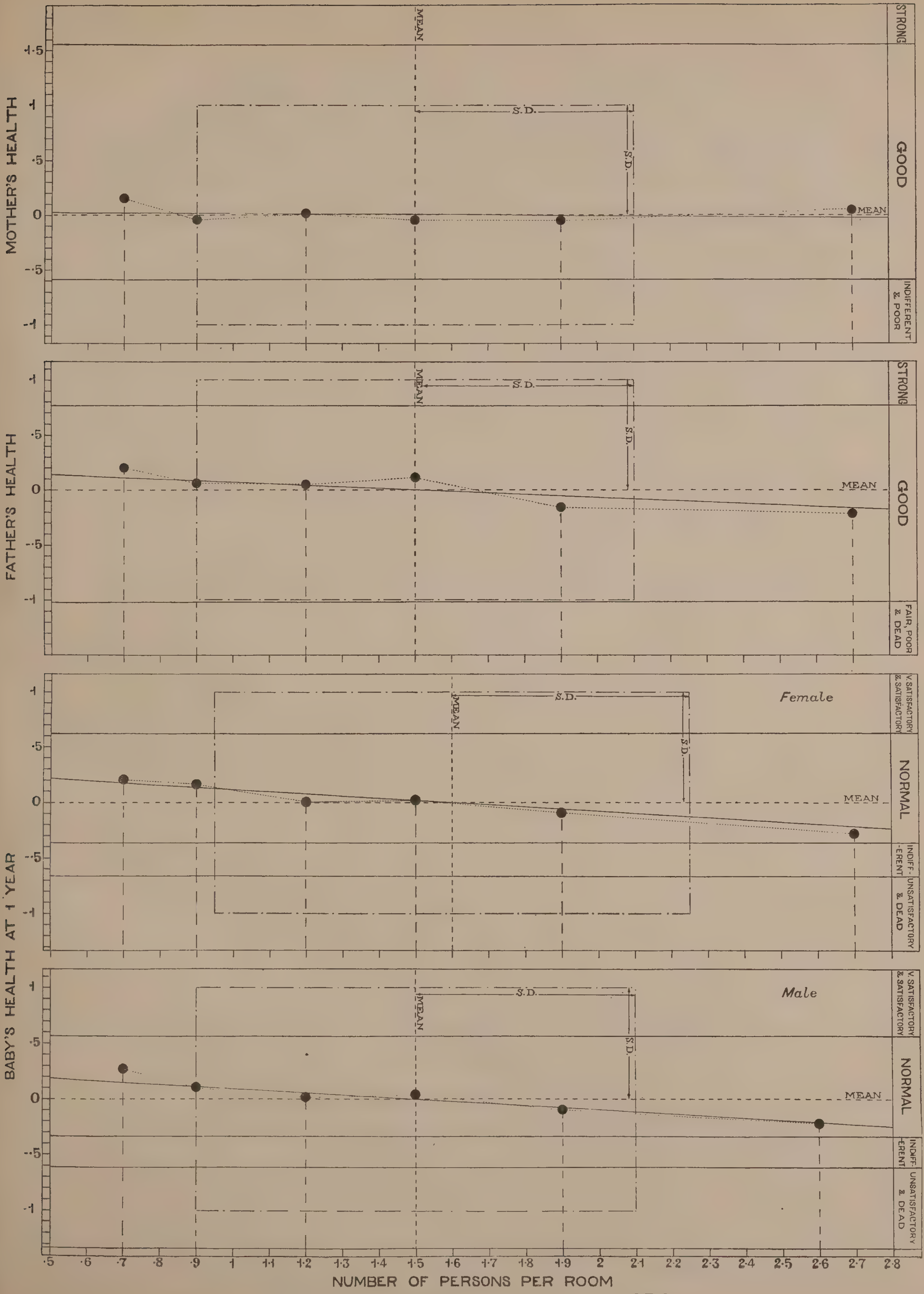

Diagram XXVII. Effect of Crowding on Parents and Baby.
(Rectangles represent the doubled standard deviations.)

(*c*) *Father's Wage and Health of Family.* There are considerable difficulties in the wage data. In the first place wage is not infrequently omitted; in the next place where it is recorded, other means of subsistence often exist, so that Father's Wage is not an adequate measure of economic status; and lastly there are invariably a number of cases of 'no wage'; these form a lump at the end of the frequency distribution and render it very difficult to devise proper methods of reduction. The 'no-wage' group arises from more than one source, (*a*) the Father is merely for the time being out of work owing to strikes, lock-outs or slackness of trade; (*b*) the Father is unemployed owing to bad health either of a permanent character or to temporary illness; (*c*) the Father is unemployable, a ne'er-do-well, 'corner man' or drinker. It is clear that the omission of the no-wage group, since it includes (*b*), will seriously affect the influence of Father's Wage on Baby's Health, if wage be a measure of Father's physique. Thus in the less than 2*s.* wage group there were 26·5 °/。 of men in 'poor' health, and in the general population excluding the no-wage group only 10·3 °/。 of men in poor health. And again when we consider wage as a measure of Father's orderly habits, if we exclude the no-wage group, we exclude under (*c*) the worst type of Father. In the present case no direct records of habits of Father or Mother were made, and wage is our only standard of Father's efficiency.

The following table will give a very good insight into this difficulty of our present material. It is condensed from the working table, but it suffices to bring out the necessary points.

TABLE LXXIII.

Father's Health Categories	Father's Wage in Shillings*																Totals
	Under 4	4—8	8—12	12—16	16—20	20—24	24—28	28—32	32—36	36—40	40—44	44—48	48—52	52—56	56—60	60—64	
Strong ...	18	—	1	3	8	29	17	12	5	3	1	1	1	—	1	—	100
Good ...	30	1	2	6	19	81	66	47	14	6	7	1	—	—	—	—	280
Indifferent	2	—	—	3	3	3	2	5	—	—	—	—	—	—	—	—	18
Poor	18	1	2	—	4	13	6	7	1	4	2	—	—	—	—	—	58
Totals ...	68	2	5	12	34	126	91	71	20	13	10	2	1	0	1	0	456

TABLE LXXIV.

Health Groups	Mean Wage for each Health Group	
	No-wage Group Included	No-wage Group Excluded
Strong	21·16*s.*	25·59*s.* {21·96*s.*}
Good	21·69*s.*	25·37*s.* {21·74*s.*}
Indifferent ...	20·74*s.*	23·21*s.* {19·58*s.*}
Poor	17·65*s.*	25·16*s.* {21·53*s.*}
All Categories...	21·68*s.*	25·31*s.*

* Wages being only tabled to the penny, a group such as 8*s.*—12*s.* signifies all wages between 7*s.* 11½*d.*—11*s.* 11½*d.* or its centre is at 9*s.* 11½*d.* or at 9·9583 shillings.

We see that nearly 15 °/。 of men were practically unemployed at the time of the record, and that they form a heterogeneous lump at the tail of the distribution. Table LXXIV shows the differences which result when we exclude and include the no-wage group.

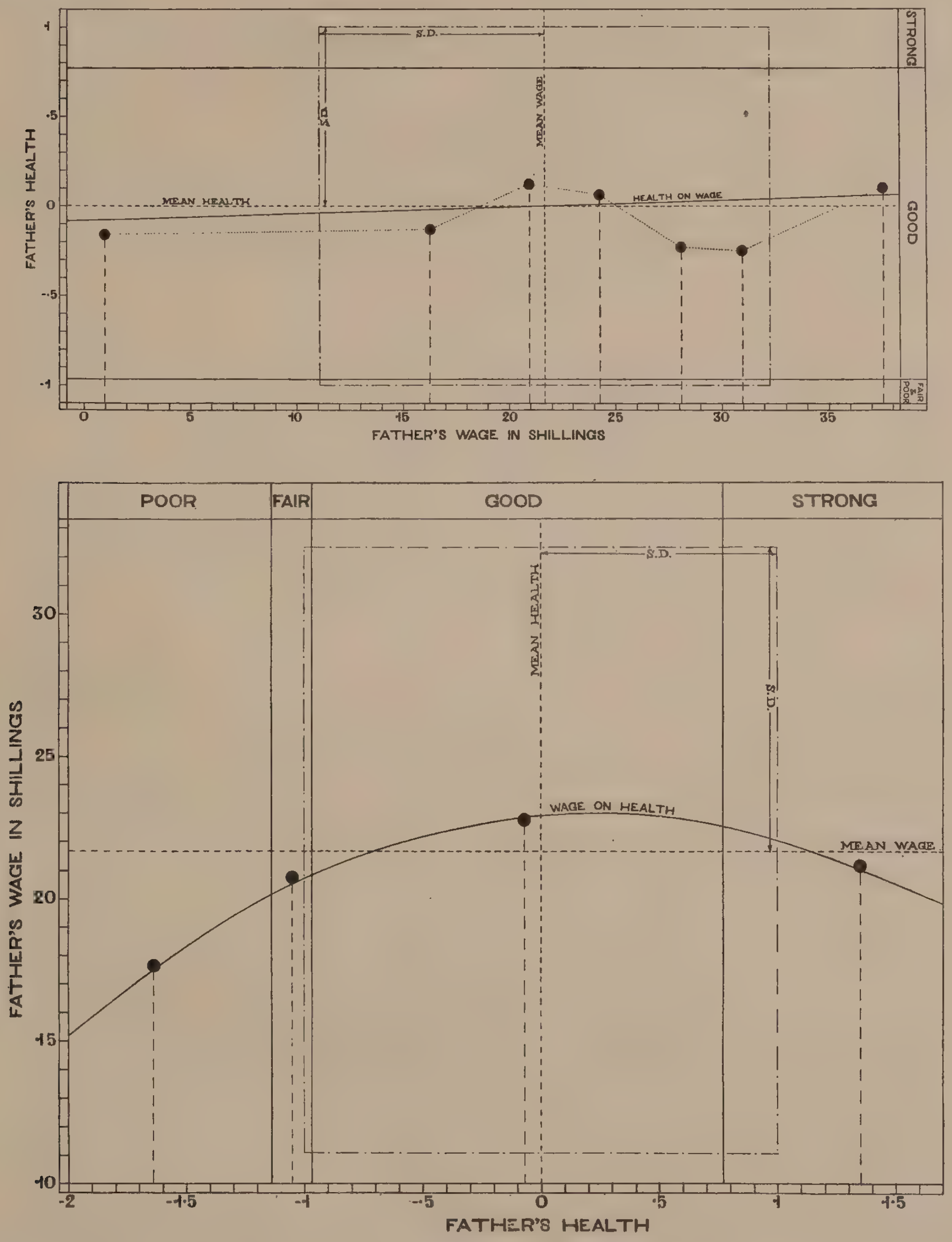

Diagram XXVIII. Wage and Health. (Rectangles represent the doubled standard deviations.)

The average difference in wage excluding the no-wage group is 3·63*s*. and if we subtract this from each mean wage of the 'no-wage group excluded' column we obtain the figures in curled brackets. It is then clear that we have got an especially enhanced wage for the 'poor' health group by excluding the Fathers so bad in health that they had no wage at all.

This is illustrated again if we take the correlation between Health and Wage, it is ·0375 ± ·0342[*] excluding the 'no-wage' group and rises to ·4032 ± ·0590[†] when we include that group. It would rise still higher if we could exclude the 'strong' and 'good' health fathers who are wastrels[‡].

On the other hand it is very difficult to include from the statistical standpoint this 'no-wage' lump at the end of our distribution.

If we leave out the 'no-wage' group and try to find out the influence of Husband's wage on Wife's health we have a correlation of only ·0707 ± ·0247, which is just significant. The mean wages for each health group of wife are:

TABLE LXXV.

Health of Wife	Wage of Husband
Strong	25·96*s.*
Good	25·10*s.*
Indifferent ...	24·69*s.*
Poor	23·89*s.*
All Categories ...	24·98*s.*

A uniform decrease of wage with health of wife, and if σ_h be the standard deviation of health of wife

Deviation of Wife's Health from mean = $\cdot 0109\sigma_h \times$ (Excess of wage over mean wage).

Now the whole range of good health in the wife is $1\cdot 9640\sigma_h$ and if we suppose this to correspond to 100 units of health, it requires 1*s.* increase of wage to raise on the average the wife's health ·555 units. Accordingly to lower the wife of mean health to the border of 'indifferent health' from which she is distant 29·8 units of health would require a loss of 53·7*s.* in wages, an amount which only one of our Husbands received (and his wife was in the indifferent health class!). In the same way to raise the wife of mean health to the border of the 'strong' health category would require 70·2 units of health or an increase of 126·5*s.* in the weekly wage!

In order to be quite certain as to the smallness of the relation between Father's Wage and Mother's Health the schedules were re-examined and a number were included which for various reasons had not been included in the first inquiry[§]. We now retained the whole group of Fathers without employment or in receipt of slight casual earnings (Group 0·96*s.*).

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[*] Obtained from the means of the wages arrays for each health corrected for class-index of health.

[†] See p. 12, ftn.

[‡] Various other methods in other inquiries have been made to surmount these difficulties, as taking wage when last employed; but the wastrels may have been long periods out of employment and be at the date of record quite incapable of earning such a wage.

[§] For example, adequate information as to the baby was not provided, etc

TABLE LXXVI.

Mother's Health	Mean of Wages in the selected Subranges								Totals
	0·96*s.*	12·81*s.*	18·47*s.*	20·96*s.*	24·11*s.*	27·81*s.*	31·36*s.*	38·28*s.*	
Strong	5	2	7	12	18	8	7	8	67
Good	96	30	45	90	140	55	56	54	566
Indifferent ...	24	4	13	38	39	13	20	8	159
Poor	9	4	9	22	15	9	8	4	80
Totals	134	40	74	162	212	85	91	74	872

The mean wage is now 21·29*s.*

If we assume the wage arrays of mother's health can have their means determined as if they were Gaussian distributions, we find for the correlation $r = \cdot 0510 \pm \cdot 0228$, or a value slightly less than in the previous investigation. We have accordingly in the latter not exaggerated the slightness of the relation between father's wage and mother's health by omitting the heterogeneous class of unemployed. The accompanying Diagram XXIX (top figure) shows at a glance how little relation father's wage has to mother's health. If we were to regard the 38*s.* wages as effectively increasing the mother's good health, we should be compelled to explain why 21*s.* wages effectively decreases it relatively to 18*s.* 6*d.*! Both are probably due merely to the variations of random sampling.

Clearly the actually observed variations in wage, even if causative, have very little influence on the health of the wife. We doubt if they are even causative, but believe that they merely represent the fact that a strong woman will get a fit husband, and a woman in indifferent or poor health only a husband with less wage earning power. This view of the matter is confirmed by the fact that there is a far higher correlation between the healths of husband and wife than between the wage of husband and health of wife.

The correlation is $\cdot 2890 \pm \cdot 0178$ and our Diagram XXX illustrates the regression of Father's Health on the assumption that a normal scale be used for both. The correlation is slightly greater but of the same order as we have found for assortative mating in eye colour, stature and longevity, etc., in a number of which cases the source cannot lie in a common environment.

If indeed it be supposed that the association of health in husband and wife is due to the prolonged living in a common environment, we can reply that the correlation of parents' health with age is a low one—numerically about 0·1—and accordingly the correlation for husband and wife's health is hardly changed, if corrected for their ages. We are really, we believe, dealing with a case of assortative mating—the fit and strong tending to select their like.

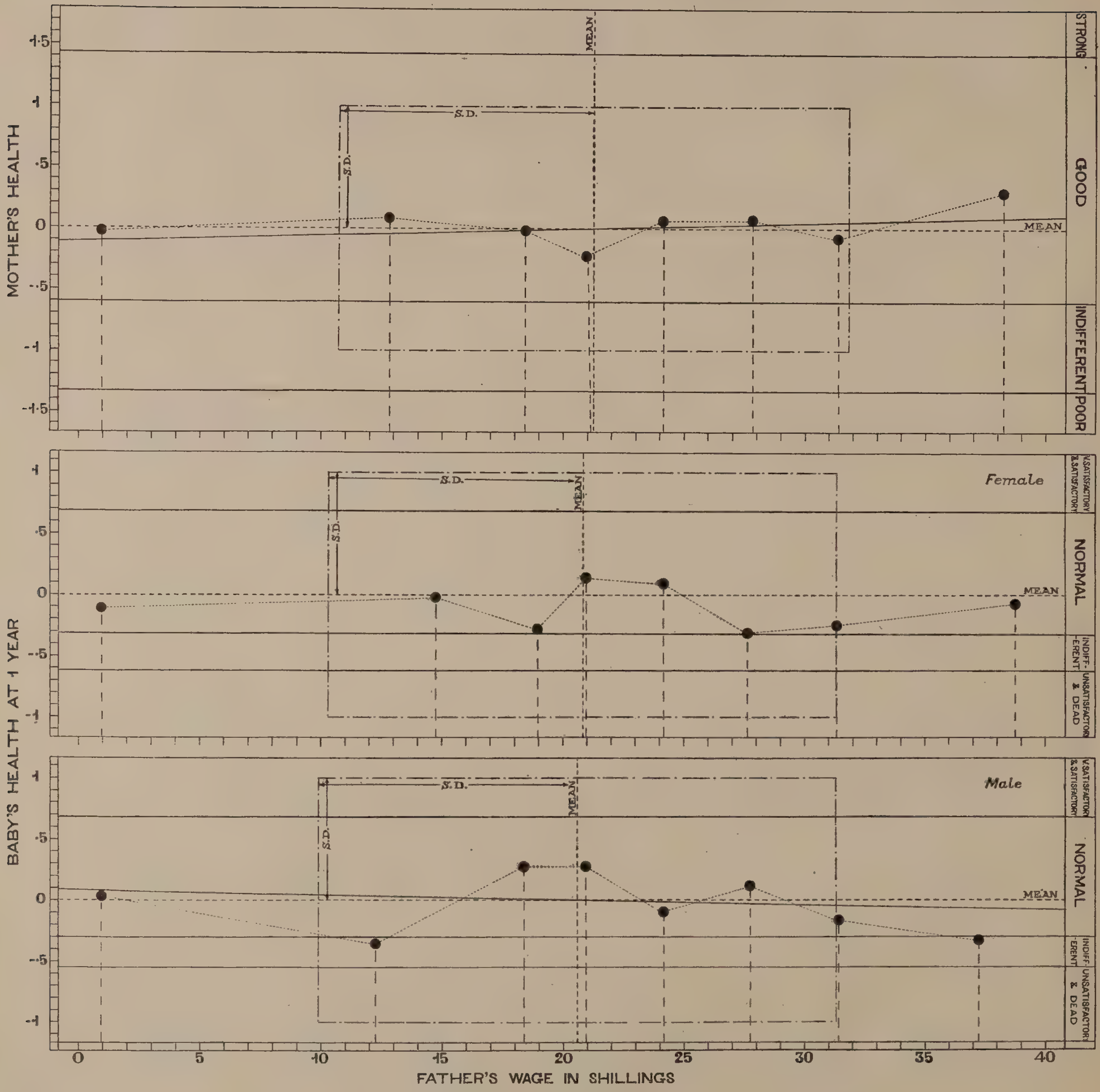

Diagram XXIX. (Rectangles represent the doubled standard deviations.)

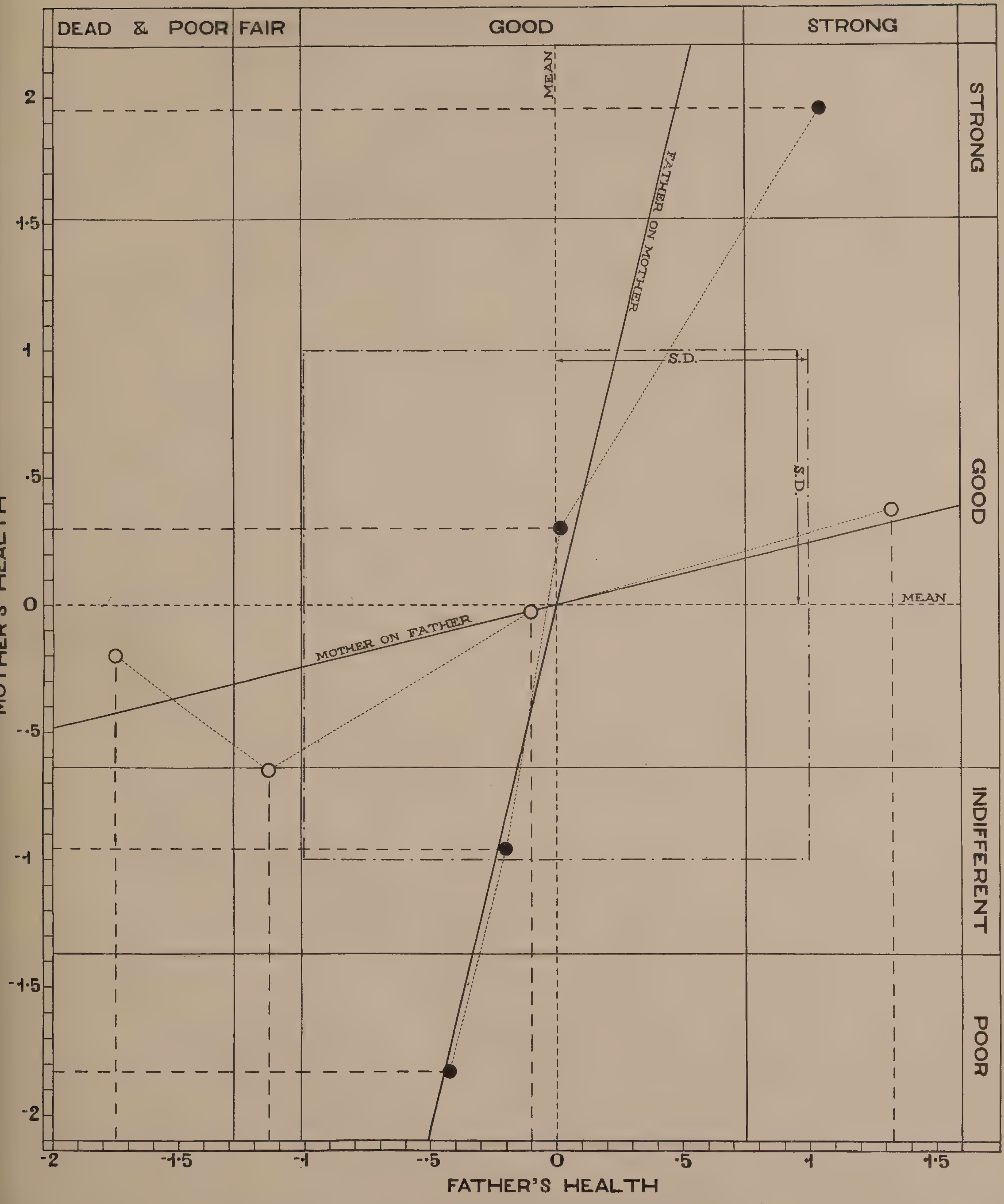

DIAGRAM XXX. (Rectangle represents the doubled standard deviations.)

The table in question is the following:

TABLE LXXVII.

Health of Father	Health of Mother before Pregnancy				Totals
	Strong	Good	Indifferent	Poor	
Strong	45	169	35	23	272
Good	26	540	135	44	745
Indifferent ...	—	33	21	13	67
Poor and Dead	7	69	22	23	121
Totals	78	811	213	103	1205

In some 50 °/o of cases the health of the Father was not given. It may often be difficult to obtain by inquiry from the mother, but it is essential that it should be provided. We have, however, no reason for supposing any selection.

Now in the light of these results let us turn to the problem of the influence of Father's Wage on Baby's Health. To apply the ordinary statistical methods we are bound to omit the unemployed and practically wageless group, but in doing so we omit a number of Fathers whose health is bad. But if Father's Health be a factor which influences Baby's Health, then by rejecting these Fathers the low wage groups will appear to have healthier babies than they can really lay claim to. We shall get an artificially reduced correlation coefficient and an artificially increased correlation ratio corresponding to the interference with a linear relationship.

The following tables give Father's Wage in shillings and Baby's Health at a year:

TABLE LXXVIII.

Mean of Subrange of Wages Group		Boys					Totals	Girls					Totals
Boys	Girls	I+II	III	IV	V	VI		I+II	III	IV	V	VI	
0·96	0·96	16	22	8	13	7	66	16	20	6	11	4	57
12·26	14·77	8	4	2	3	3	20	5	6	4	4	2	21
18·39	18·96	3	11	4	8	2	28	8	12	3	3	1	27
20·96	20·96	13	29	3	19	10	74	9	28	8	12	9	66
24·19	24·15	25	33	7	10	13	88	23	28	6	15	17	89
27·76	27·63	8	10	5	10	2	35	9	12	2	4	3	30
31·41	31·34	10	16	7	6	1	40	9	14	4	2	3	32
37·27	38·73	11	15	2	3	1	32	6	13	4	1	2	26
Totals ...		94	140	38	72	39	383	85	133	37	52	41	348

Assuming the arrays normal we can calculate the regression line for health on wage in each case. In the complete tables we have the full distribution of wage and thus can determine the mean and standard deviation of wages. These are:

	Boys	Girls
Mean Wage	20·615*s.* ...	20·826*s.*
Standard Deviation ...	10·6826*s.* ...	10·5108*s.*

The correlations are:

$$\text{Boys} \quad r = \cdot 0560 \pm \cdot 0344 \quad \ldots \quad \text{Girls} \quad r = \cdot 0009 \pm \cdot 0362$$

The first of these correlations is scarcely significant, the second is certainly not significant. The regression lines are:

$$\frac{\text{Deviation in Health from Mean}}{\text{Standard Deviation of Health}} = \cdot 005{,}241 \times \text{Wages} - \cdot 108{,}04, \text{ for boys,}$$

$$= \cdot 000{,}083 \times \text{Wages} - \cdot 001{,}730, \text{ for girls.}$$

If we take the standard deviation in health to represent 100 units of health, to raise the wages from 20*s.* to 50*s.* would only correspond to a rise of 15·4 units in the boys' and 0·24 units in the girls' health. But in boys Class III, i.e. of 'Normal Health,' corresponds to a range of just 100 units of health and thus the maximum change of wage will be very far from removing the baby of normal health into either Class II or Class IV. For the graphs see Diagram XXIX (lower figures).

(*d*) *Association of Rent and Baby's Welfare.* Not being wholly satisfied with the exclusion or inclusion of the non-employed group of fathers, we determined to take as our standard of economic condition Rent of Home and to replace Baby's Health by Baby's Weight. We obtained the following tables, the data being rather sparse:

TABLE LXXIX.

Weight at 49—55 weeks	Centre of Rent Groups															
	Boys							Totals	Girls							Totals
lbs.	2/5½	2/10½	3/4½	3/10½	4/4½	4/10½	6/0½		2/4½	2/10½	3/4½	3/10½	4/4½	4/10½	6/1½	
9—*	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	2
10—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	3
11—	—	—	—	1	—	—	—	1	6	—	—	1	—	—	—	7
12—	—	—	2	1	—	—	—	3	—	—	—	6	—	—	—	6
13—	—	1	7	5	—	—	—	13	—	—	5	11	—	2	—	18
14—	2	3	7	3	—	—	—	15	1	4	11	7	—	1	—	24
15—	1	—	9	1	2	—	—	13	1	1	10	5	—	5	—	22
16—	2	1	2	5	3	—	4	17	—	8	1	10	—	2	2	23
17—	2	6	2	5	4	11	2	32	1	2	8	14	1	2	3	31
18—	1	1	4	9	9	4	2	30	—	6	3	9	7	7	2	34
19—	4	4	8	12	7	4	5	44	—	3	6	12	—	7	—	28
20—	—	2	8	5	4	4	3	26	—	—	3	1	1	4	1	10
21—	—	7	7	4	8	1	—	27	—	—	—	—	6	3	2	11
22—	—	2	2	3	2	5	1	15	—	—	—	—	6	—	—	6
23—	—	1	—	2	3	2	—	8	—	—	—	1	1	2	—	4
24—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	3
25—	—	2	—	—	2	—	—	4	—	—	—	—	—	—	—	—
26—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—
27—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—
28—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—
Totals...	12	30	58	56	47	31	17	251	9	24	47	82	24	36	10	232

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* See footnote, p. 32.

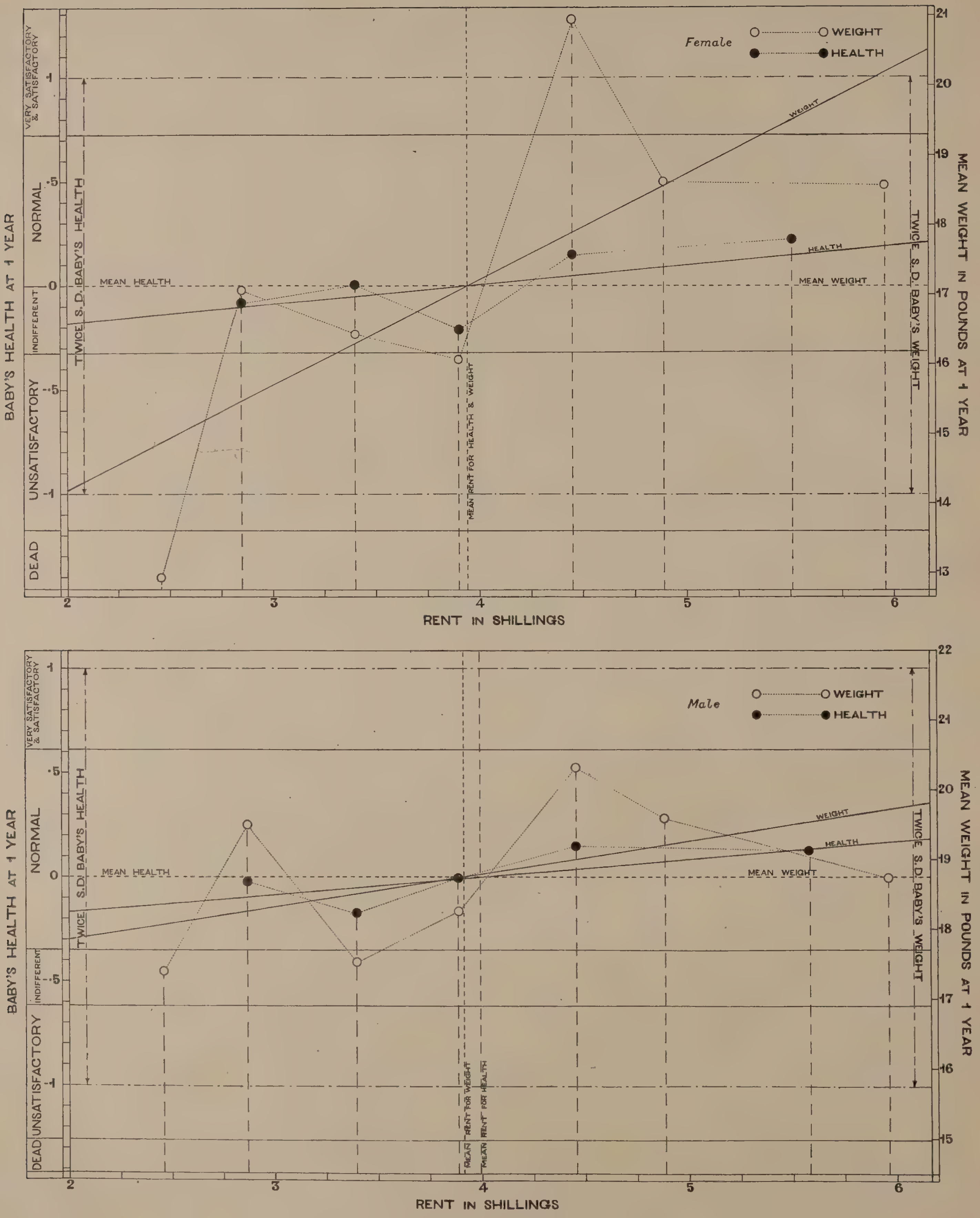

Diagram XXXI. Rent, Health and Weight of Baby.

We have:

TABLE LXXX.

	Boys		Girls	
	Mean	Standard Deviation	Mean	Standard Deviation
Weight (lbs.) ...	18·7756	2·9379	17·1197	3·0067
Rent (*s.*) ...	3·94	·879	3·92	·780
Correlation ...	$r = \cdot 1541 \pm \cdot 0416$		$r = \cdot 3818 \pm \cdot 0378$	

If R be rent in shillings and w weight of baby in lbs., then the regression lines are:

$$\text{Boys: } w = 16{\cdot}746 + \ {\cdot}51505\, R,$$

$$\text{Girls: } w = 11{\cdot}351 + 1{\cdot}47174\, R.$$

Diagram XXXI represents the regression lines. It will be seen that while the observations are somewhat erratic owing to the smallness of the two series, there is yet an increase of weight with increased rent. We notice, as we have before remarked, that the girls seem far more responsive to environmental conditions than the boys. While a shilling a week higher rent is associated with about one half pound more weight in the boys, it corresponds to nearly a pound and a half greater weight in the girls at the end of a year. The correlation between girls' weight and rent is one of the highest we have thus far reached.

The paradox—namely that Father's Wage appears to have little relation to health, but that Rent has, at any rate in the case of girl babies, a quite sensible correlation—may be to some extent explicable on the following grounds. In the first place we have the difficulty of the fathers out of employment at the time of the inquiry. In the second place Rent is possibly a better measure of general economic condition than Father's Wage. The latter is very frequently not the sole source of income, and Rent may well be a more stable measure of general welfare than Father's Wage. Lastly it does not follow that baby's weight at a year is an absolute measure of its health at a year. The better economic conditions at a year may lead to a fatter baby without its necessarily being a healthier baby. We do not see at present any form of investigation—based on the present data—which would throw light on why the female infant is so much more responsive than the male to environmental conditions. We can hardly venture as yet to suggest a physiological differentiation in this respect of the two sexes*.

To throw some light on the paradox it appeared well to investigate the direct relation of rent to health and of baby's weight at a year to its health. The following are condensed from the working tables:

---

* Is the vulgar opinion that boys are harder to rear than girls to be interpreted as meaning that they respond less to environmental conditions, or merely a popular appreciation of their higher death rate?

TABLE LXXXI.

Mean rent of Subranges		Baby's Health														
		Boy's Health						Totals	Girl's Health						Totals
Boys	Girls	I	II	III	IV	V	VI		I	II	III	IV	V	VI	
2·87	2·78	4	17	25	6	14	8	74	1	14	23	10	11	9	68
3·40	3·41	1	20	32	9	16	16	94	2	16	30	8	12	7	75
3·89	3·91	5	17	43	8	14	8	95	1	15	27	12	17	11	83
4·50	4·51	6	25	27	10	14	9	91	3	15	25	5	4	9	61
5·58	5·51	7	10	25	6	10	2	60	2	13	30	6	2	5	58
Totals ...		23	89	152	39	68	43	414	9	73	135	41	46	41	345

Working on the horizontal arrays we have:

	Boys	Girls
Correlation Coefficient ...	$r = {\cdot}0779 \pm {\cdot}0329$	$r = {\cdot}0985 \pm {\cdot}0360$
Correlation Ratio ...	$\eta = {\cdot}1200 \pm {\cdot}0327$	$\eta = {\cdot}1593 \pm {\cdot}0354$

Thus the correlation is again small, the better health being associated with the higher rented house. The difference between r and η suggests that the regression is not truly linear. Diagram XXXI (p. 74) shows graphically how Health is on the average associated with Rent. It is noteworthy that Health appears less closely associated with Rent than Weight.

We are now in a position to find the relation between baby's health and rent paid for a constant weight at a year. We have:

TABLE LXXXII.

	Boys	Girls
Rent and Health	·0779	·0985
Rent and Weight	·1541	·3818
Weight and Health	·4126	·4769
Partial Correlation of Rent and Health for constant weight at a year	$+{\cdot}0159 \pm {\cdot}0331$	$-{\cdot}1029 \pm {\cdot}0359$

Thus the correlation of Health and Rent becomes insignificant in the case of boys and actually negative in the case of girls if we allow for the weight factor. It seems therefore that rent does not directly affect health, but only does so through the weight factor, i.e. a higher rent means an economically better home, and such a home gives a better nourished baby, and a better nourished, or heavier baby, is to the extent of the correlation between weight and health a healthier baby. Rent, as far as we are able to judge, is the best character by which to judge of the general economic conditions of the family, and we believe that it would, except in very carefully worked up inquiries, be better to concentrate on rent and drop Father's Wage.

(*e*) *Mother's Employment before Birth of Infant.* In dealing with Mother's employment we are bound to consider the circumstances which determine it. How is it related to Mother's Age, the number of her previous children, and the economic position of the Father as well as his health? If we suppose it possible that Baby's Health depends on Father's Health and on Mother's Age, then maternal employment may be associated with older mothers and physically inferior fathers and baby's worse health in the case of employed mothers, if it exists, might merely result from the father being physically inferior and the mother older.

We were only able to form three categories of mother's employment, namely, Factory, Charing, and ordinary Home Duties, into which last category most of the women fall.

The following table gives the distribution of employment and age:

Table LXXXIII.

Employment	Mother's Age																													Totals
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	
Factory	2	10	8	28	26	24	18	20	24	7	12	9	9	11	7	10	6	7	8	7	5	3	—	—	—	—	—	—	—	261
Home	—	12	22	39	48	46	54	72	51	62	44	47	60	36	45	42	31	38	32	20	33	20	9	10	7	6	—	2	2	890
Charing	—	2	2	2	1	—	4	4	3	3	6	8	4	3	9	7	4	1	9	3	2	3	3	3	1	—	1	—	1	89
Totals	2	24	32	69	75	70	76	96	78	72	62	64	73	50	61	59	41	46	49	30	40	26	12	13	8	6	1	2	3	1240

We have for the mean ages of each group:

Factory	26·97 years
Home	29·50 ,,
Charing	31·99 ,,
Whole Population ...	29·18 ,,

The younger women are therefore factory employed and the elder women do charing. If we arrange in the above order and assume a normal scale for employment the correlation is ·2674 ± ·0178*, a quite significant result. It may at first sight appear an arbitrary order to take Factory, Home, Charing, but the relative ages suggest to some extent a reason, namely, in the three categories the factory mothers will have fewest and the charing mothers most children; and factory with 2 to 3 children may be less hard work than charing with 4 to 5 children. The following is the table for employment and children:

Table LXXXIV.

Employment	Number of Children																Totals
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Factory ...	109	47	35	17	20	12	13	2	3	2	—	1	—	1	—	—	262
Home ...	200	187	127	108	69	64	66	31	24	12	2	8	1	2	2	1	904
Charing ...	14	10	5	13	18	9	10	7	3	2	—	—	1	—	—	—	92
Totals ...	323	244	167	138	107	85	89	40	30	16	2	9	2	3	2	1	1258

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* Corrected for class-index of employment = ·3221.

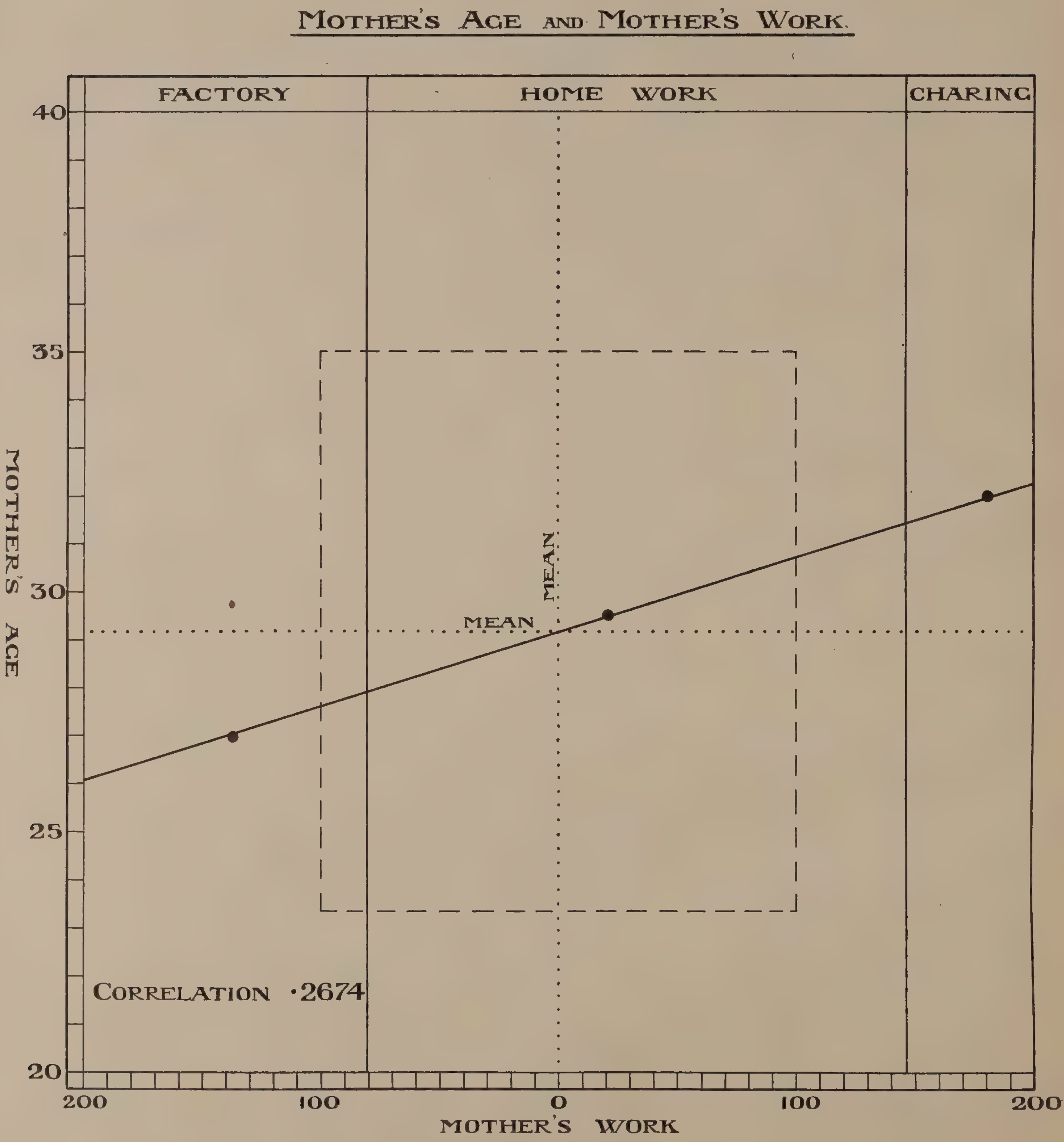

DIAGRAM XXXII. (Rectangle represents the doubled standard deviations.)

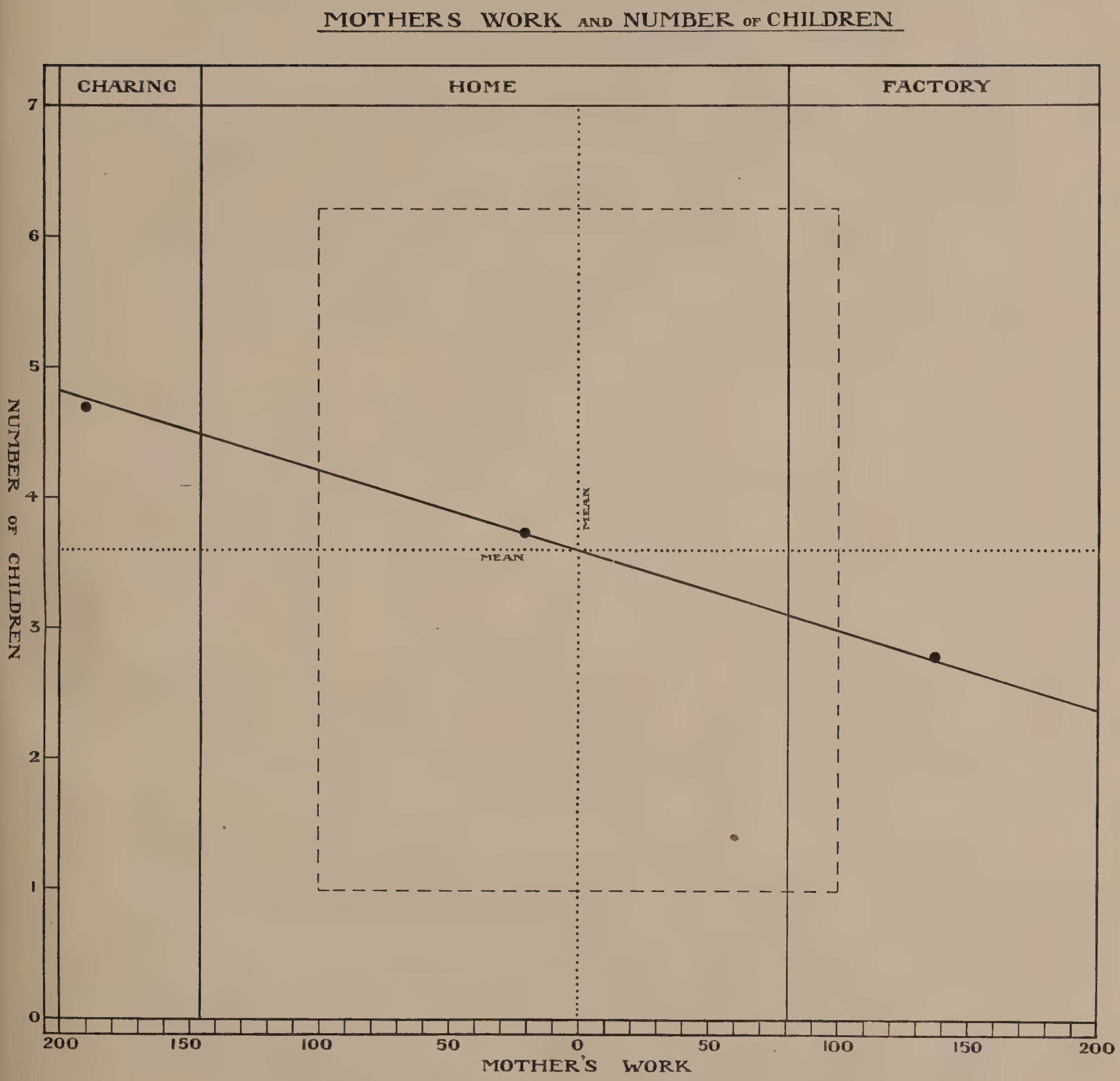

DIAGRAM XXXIII. (Rectangle represents the doubled standard deviations.)

From Table LXXXIV we deduce the following values for mean number of children in the incomplete families:

Factory Mothers	2·78
Home Mothers	3·72
Charing Mothers	4·68
Whole Population ...	3·60

It is clear therefore that employed mothers really consist of two classes: young mothers, with two or three children, in the factory, and old mothers, with four or five children, doing work of a charing character. The influence of employment of the mother on the health of the baby must be considered from this aspect. The correlation between employment of mother and the size of her family is ·2330 ± ·0180 and corrected for class-index correction ·2806 ± ·0175*. It is not without interest to determine whether there is any relation between employment of mother and size of family for constant age of the mother. The table below gives the age of mother and size of her family for 2058 cases.

TABLE LXXXV.

Mother's Age at last Confinement	Number of Children																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Totals
17	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
18	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
19	29	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	35
20	41	11	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	54
21	89	22	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	115
22	76	30	16	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	124
23	62	37	16	8	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	124
24	50	61	27	9	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	148
25	50	52	28	19	5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	156
26	32	33	32	20	11	2	—	—	—	—	—	—	—	—	—	—	—	—	—	130
27	36	29	22	21	12	5	1	—	—	—	—	—	—	—	—	—	—	—	—	126
28	21	31	21	23	16	8	1	—	—	—	—	—	—	—	—	—	—	—	—	121
29	18	18	15	18	22	8	4	—	—	—	—	—	—	—	—	—	—	—	—	103
30	17	17	14	17	21	12	6	1	—	—	1	—	—	—	—	—	—	—	—	106
31	7	8	15	17	11	14	3	2	1	—	—	2	—	—	—	—	—	—	—	80
32	9	11	18	14	14	16	11	—	—	2	—	—	—	—	—	—	—	—	—	95
33	8	11	7	10	13	9	13	6	5	1	—	—	—	—	—	—	—	—	—	83
34	3	15	11	7	6	11	9	5	3	2	1	—	—	—	—	—	—	—	—	73
35	3	4	3	10	14	8	15	11	5	2	—	1	—	1	—	—	—	—	—	77
36	2	9	11	5	13	11	14	3	4	4	1	1	—	—	—	—	—	—	—	78
37	2	6	6	6	4	6	3	5	4	1	—	—	1	1	—	—	—	—	—	45
38	1	6	6	4	11	12	8	7	5	3	—	—	—	3	—	—	—	—	—	66
39	1	4	1	7	1	2	9	4	3	2	1	—	1	—	—	—	—	—	—	36
40	—	1	1	2	2	3	2	3	2	1	1	3	—	—	—	—	—	—	—	21
41	—	1	3	3	2	—	5	3	1	2	—	—	—	—	—	—	—	—	—	20
42	1	1	—	1	—	2	1	3	2	1	2	—	1	—	—	—	—	—	1	16
43	1	1	—	—	—	1	1	1	—	1	—	3	—	—	—	—	—	—	—	9
44	—	—	—	—	—	—	1	1	—	—	1	—	1	—	—	—	—	—	—	4
45	—	—	—	—	—	—	—	1	1	—	—	—	—	1	1	—	—	—	—	4
46	—	—	—	1	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	3
Totals...	565	425	279	224	180	132	107	56	37	22	9	10	4	6	1	—	—	—	1	2058

---

* The corrected η for size of family on employment is ·3080.

The mean age is 29·01, and the standard deviation in age is 5·807. The mean number of children is 3·39 in these incomplete families and the standard deviation of size of family 2·507. The correlation between mother's age and size of family is:

$$r_{af} = \cdot 6798 \pm \cdot 0080.$$

Accordingly the correlation of employment and size of family for constant age of mother, using corrected values of employment and size of family, and employment and mother's age is:

$${}_a r_{af} = \frac{\cdot 2806 - \cdot 6798 \times \cdot 3221}{\sqrt{\cdot 1 - (\cdot 6798)^2}\sqrt{1 - (\cdot 3221)^2}} = \cdot 0887 \pm \cdot 0189,$$

or the bulk of the correlation between employment and size of family is due to the relative ages of the women. Given, however, a factory woman and a woman of the same age who does charing, the former will have somewhat fewer children. This probably signifies that limitation of the family is somewhat more frequent with the factory woman than with the woman who takes casual and often untrained employment*. The present data, however, from a town which does not give large numbers

MOTHER'S AGE AND NUMBER OF CHILDREN

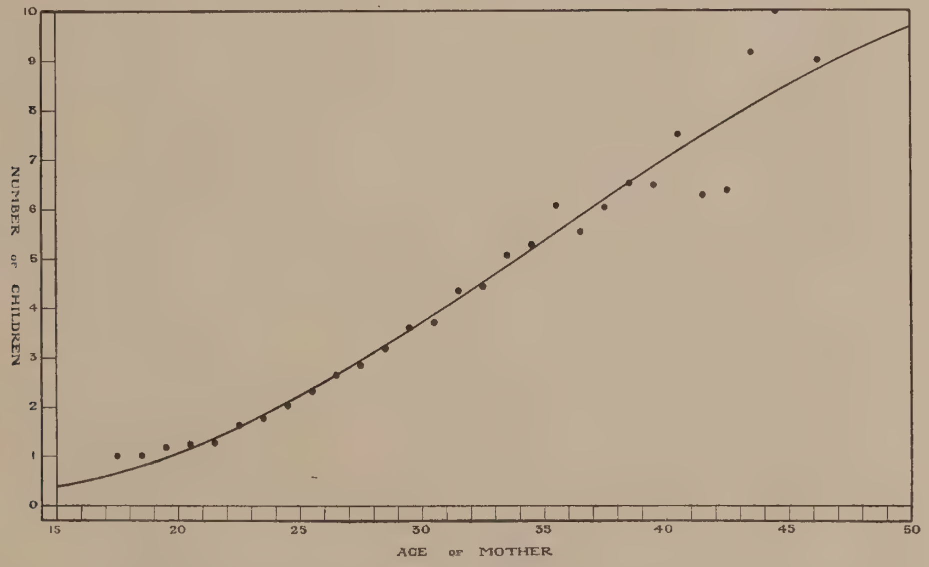

DIAGRAM XXXIV.

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* Looked at in a rather cruder manner we have:

TABLE LXXXVI.

	Factory	Home	Charing	General Population
Mother's Mean Age ...	26·97	29·50	31·99	29·18
Mean Number of Children	2·78	3·72	4·68	3·60

Hence if we assumed the mean age at marriage to be 19·72 years and the average interval between births to be 2·63 years, the theoretical mean number of children would be for women of these mean ages:

2·76 3·72 4·67 3·60

This does not, however, allow for the average interval being shorter between the earlier births.

MOTHER'S WORK AND FATHER'S WAGE

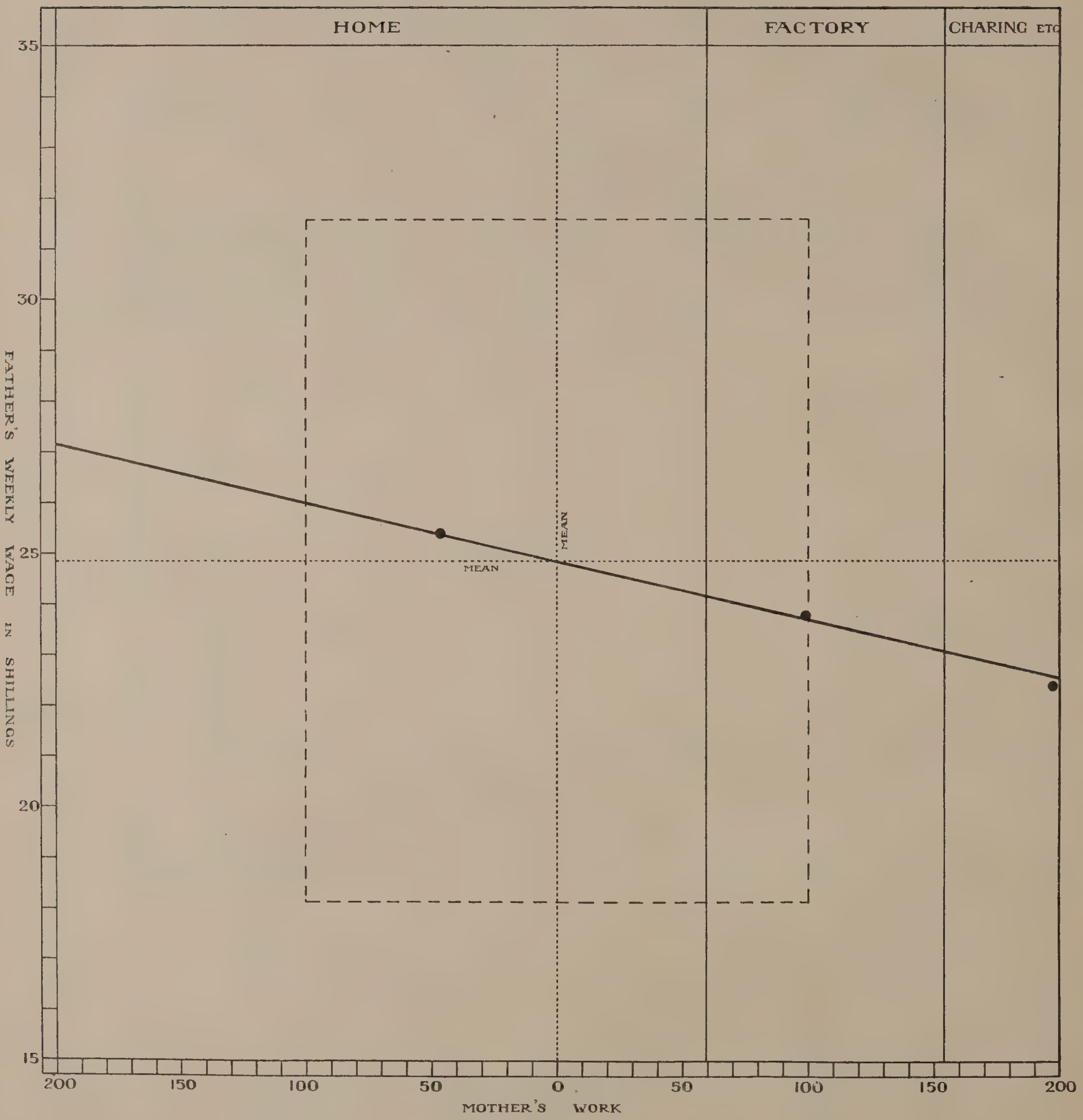

DIAGRAM XXXV. (Rectangle represents the doubled standard deviations.)

of women factory employment, indicate that factory, home or casual work for women does not lead either of purpose or from physiological influence to any *very marked* differentiation in the size of family.

For an early series of 1476 mothers the regression curve was plotted, and it was seen that the correlation between mother's age and size of family is not linear, and it was fitted with a cubic (Diagram XXXIV, p. 81). This curve will serve to predict when a child is born to a woman of given age the probable number of her earlier confinements.

We will now examine how far the Health and Wage of Father are associated with the Employment of the Mother. First as to Wage of Father. We have only a record of Mother's Employment and Father's Wage in 405 cases if we exclude the Out of Employment group:

Mean Wage of Husband:		
	Home Mothers ...	25·39*s.*
	Factory Mothers ...	23·76*s.*
	Charing Mothers ...	22·36*s.*
	All Mothers	24·85*s.*

The correlation is ·1723 ± ·0325 and Diagram XXXV shows that there is quite a sensible correlation between Mother's Employment and Father's Wage. This will be augmented if we include Fathers out of work or in receipt of no wages.

The next table gives a slight variant on this result. We tabled Father's Wage and Mother's Employment *after* birth of child. The mean wage of the husbands of the wives variously employed is as follows:

TABLE LXXXVII.

	Including 'no wage'	Excluding 'no wage'
Whole Population ...	19·51*s.*	24·43*s.*
Home Mothers ...	22·26*s.*	25·17*s.*
Factory Mothers ...	13·23*s.*	22·83*s.*
Charing Mothers ...	14·58*s.*	20·51*s.*
Percentage of outworkers*	Father without wage ... 60·9 °/₀	
	Father in receipt of wage ... 16·7 °/₀	

The mother's outwork is therefore largely a result of father's lack of work, and is an index to condition of father and of home.

If we include the no-wage group then the average wage of the husbands of the women who do charing is higher than that of the husbands of the women who do factory work after confinement. But if we exclude the no-wage group, then the wage of the husband of the factory mother is higher than the wage of the husband of the woman who does charing. The latter husband is probably an older man and of a lower grade. It will, however, be seen that we ought to put the three categories Home,

---

* The wives of unemployed men turn to factory rather than to charing work, as we may see from the percentages of charwomen in the two cases, i.e. 12·0 °/₀ and 7·4 °/₀. We may also note that while only 11·5 °/₀ of Home Mothers have husbands out of work, and 28·9 °/₀ of Charing Mothers, no less than 42·1 °/₀ of the women who work in factories after the birth of the child have husbands out of work.

TABLE LXXXVIII.

Wage[*]	Mother's Employment after Birth			
	Home	Factory	Charing	Totals
None	36	45	11	92
6/11½	1	—	—	1
8/11½	1	—	1	2
10/11½	3	—	—	3
12/11½	2	1	—	3
14/11½	7	4	2	13
16/11½	4	5	5	14
18/11½	20	8	3	31
20/11½	70	14	7	91
22/11½	33	5	1	39
24/11½	42	10	6	58
26/11½	12	7	2	21
28/11½	17	2	—	19
30/11½	25	2	—	27
32/11½	7	2	—	9
34/11½	12	—	—	12
36/11½	9	2	—	11
38/11½	2	—	—	2
40/11½	5	—	—	5
42/11½	—	—	—	—
44/11½	3	—	—	3
...	...	...	...	...
56/11½	1	—	—	1
Totals ...	312	107	38	457

Factory and Charing in different orders according as we include or exclude the unemployed husbands. The fact is that each wage table like the present requires working out in half a dozen different ways to appreciate its bearings. We shall content ourselves with working it out as a fourfold table in order to reach some appreciation of the magnitude of the association[†], and to some extent control this by the use of

TABLE LXXXIX. *Employment of Mother and Wage of Father.*

Wage	Homework	Outwork	Totals
Under 21/11½	144	106	250
Over 21/11½	168	39	207
Totals	312	145	457

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[*] See footnote, p. 32.

[†] The continuity of the amount of Mother's postnatal employment may be valid although the classes of employment of mother are qualitative. Again it is unlikely that all unemployed men were out of work all the first year of life of their offspring, or that all the waged men were in employment during the same year. The division of wages corresponds roughly to higher and lower capacity for wage earning.

biserial r, the two series being Home and Outwork. The correlation coefficients thus determined are as follows:

TABLE XC.

	Tetrachoric r	Biserial r
Including 'out of works' ...	$-\cdot4097 \pm \cdot0455$	$-\cdot4767 \pm \cdot0341$
Excluding 'out of works' ...	$-\cdot2498 \pm \cdot0582$	$-\cdot2749 \pm \cdot0462$

The divergence of the two methods, while considerable, was to be expected, as the distribution is not normal either with or without the lump concentrated at no wages*. For any conclusions to be derived from the result we can take mean values of $-\cdot44$ and $-\cdot26$, and we may then draw two inferences:

(i) The relation of Mother's Employment after confinement to Father's Wage is closer than her Employment before confinement to Father's Wage ($-\cdot17$).

(ii) It is the Unemployed Fathers rather than the Low-Waged Fathers who increase the intensity of the correlation.

Probably many of these out-of-work fathers are chronic out-of-works, unemployables or wastrels, and therefore not infrequently physically or mentally inferior. The correlation of Father's Health and Wage including the unemployed is fairly intense ($\cdot40$), and thus the employment of mother after birth carries us to a group of inferior Fathers, who by their habits and through heredity may react as much as the actual employment of the mother on the baby's health. The Health of the Father and the habits of both Father and Mother are not given adequately in the present data. We have them, however, in other material, and we have good reason to believe them the really fundamental factors of infant welfare. These are matters which should be most carefully recorded at all baby-clinics, and which require considerable skill and tact in their ascertainment.

We next turn to the influence of Father's Health on Mother's Employment and have the following table:

TABLE XCI.

Mother's Employment	Father's Health				Totals
	Good	Fair	Poor	Dead	
Home	422	24	26	2	474
Charing ...	21	7	10	2	40
Factory ...	105	7	7	—	119
Totals	548	38	43	4	633

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* Actually for the biserial method we took it at 11½*d*. as in some cases the men were stated to earn a shilling or two. There was no statement of unemployment pay, but it probably existed in some cases.

The best we can do here is to form a fourfold table as follows:

TABLE XCII.

Mother's Employment before birth	Father's Health		
	Good	Not Good	Totals
Homework ...	422	52	474
Outwork	126	33	159
Totals	548	85	633

Correlation from tetrachoric r is $\cdot 2423 \pm \cdot 0551$, very much of the same order as we have found between Mother's Employment and Father's Wage.

These results show that while Mother's Employment does to a sensible extent depend on Father's Wage and Father's Health (about a quarter up the scale of association), they cannot be the only causal factors; probably others are the wife's desire to have money under her own control, and the increased comfort it brings to the home. It may bring the matter better before the reader, if we say that while 25·1 °/ₒ of all mothers did other than homework, only 20·0 °/ₒ of wives whose husbands earned 30*s.* a week and over did outwork, while 29·8 °/ₒ of wives with husbands earning less than 30*s.* did outwork. And this percentage of 20 maintains itself to even the highest wage-earners. Their wives do not do charing, but are factory employed. We have only two men recorded as earning 50*s.* and upwards, but the wife of one was employed in a factory. We think it may be safely said that while wage has influence on Employment of Wife, it is hardly the dominant factor. Wage and physique of Father are associated with Employment of Mother, but not to such a marked extent that Employment of Mother is synonymous with a poor home and a Father of bad Health or bad Habits.

We can now turn to our main problem and inquire into the influence of Mother's Employment on Health and Weight of Baby. Here again the matter is obscured by two preliminary difficulties. Is the health of the mother associated with her employment? We have seen that her age is associated with her employment. Is her age associated with her health? Closely allied with her age is the question of the number of children she has given birth to, and the influence of the order of birth on her health and the health of her baby.

The following table gives the distribution of Mother's Health with her Occupation:

TABLE XCIII.

Mother's Occupation	Mother's Health			
	Very Good and Good	Indifferent	Poor	Totals
Home ...	572	150	55	777
Factory ...	148	47	15	210
Charing ...	55	17	7	79
Totals ...	775	214	77	1066

Some insight into the association of Health and Occupation can be found from the following percentages:

TABLE XCIV.

Mother's Occupation	Very Good and Good Health	Poor Health
Home	73·6 °/ₒ	7·1 °/ₒ
Factory	70·5 °/ₒ	7·1 °/ₒ
Charing	69·6 °/ₒ	8·9 °/ₒ
All Mothers ...	72·7 °/ₒ	7·2 °/ₒ

It is clearly the Charing women who are most differentiated in health; the Home mothers have just the same percentage in Poor Health as the Factory women, but a somewhat better percentage in Good Health. The whole percentage differences are, however, very small and not of marked significance*. The Charing mothers are, as we might anticipate, a rather feebler, inferior class; but even here the distinction is not very marked. The Charing mother really only differs from the usual wife of the lower working class in that she does out-charing as well as home-charing.

To get a second appreciation of the intensity of the correlation we may make a fourfold table as follows:

TABLE XCV.

Mother's Employment	Mother's Health		Totals
	Good	Not Good	
Homework ...	572	205	777
Outwork ...	203	86	289
Totals	775	291	1066

The correlation is given by tetrachoric r:

$$r = \cdot 0592 \pm \cdot 0371.$$

The correlation is therefore barely significant, and as it is not of any utility to correct for correlation under 0·1, we need not really allow for the influence of mother's employment on her health.

Turning to the relation of Mother's Health to Mother's Age, we have the following condensed table:

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* Thus the factory mothers are really 70·5 °/ₒ ± 2·1 °/ₒ which is not significantly different from the percentage of all mothers.

TABLE XCVI.

Mother's Health	Mother's Age															Totals
	17—18	19—20	21—22	23—24	25—26	27—28	29—30	31—32	33—34	35—36	37—38	39—40	41—42	43—44	45—46	
Very Good and Good	3	58	143	147	163	131	126	90	90	82	60	30	20	6	3	1152
Indifferent	—	7	17	22	35	31	27	23	16	15	14	9	2	—	1	219
Poor	1	1	10	13	10	10	8	13	10	11	5	6	4	2	1	105
Totals	4	66	170	182	208	172	161	126	116	108	79	45	26	8	5	1476

The mean ages corresponding to the health categories are:

Very Good and Good ...	28·81 years
Indifferent	29·58 ,,
Poor	30·80 ,,
All Mothers	29·07 ,,

Thus there exists a correlation between age and health. We find this by the method

MOTHER'S AGE AND MOTHER'S HEALTH

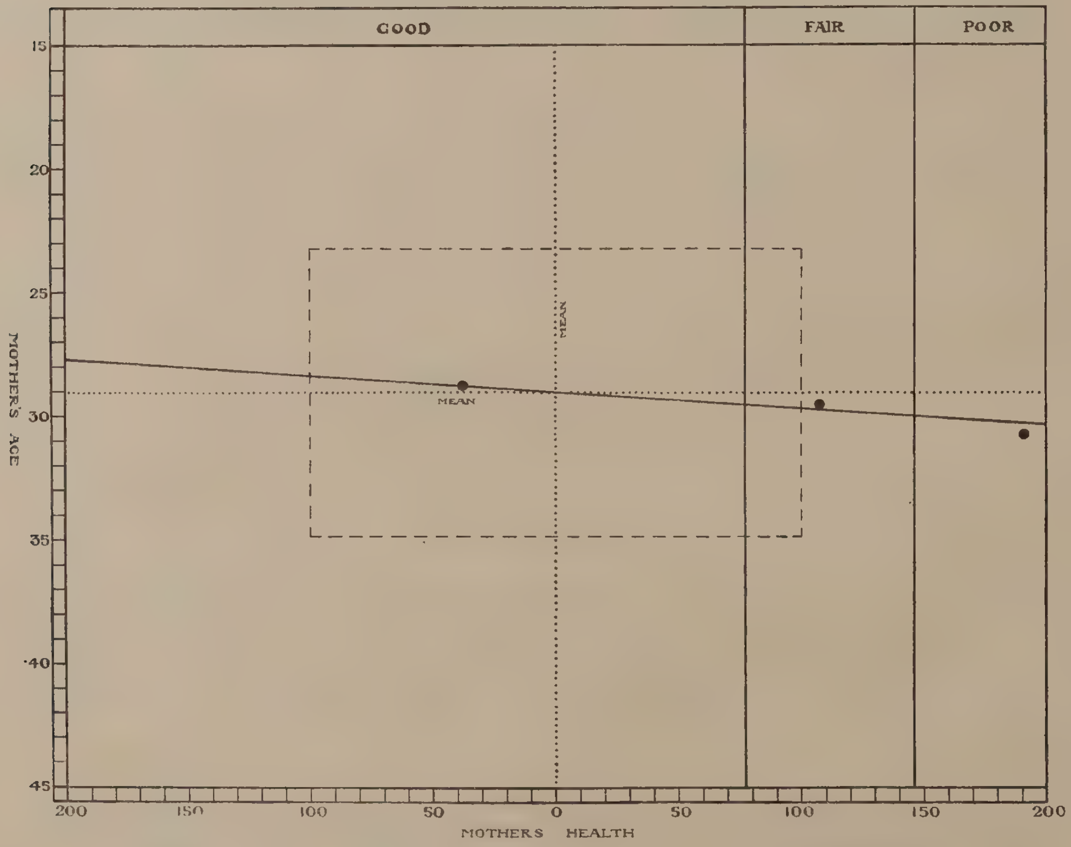

DIAGRAM XXXVI. (Rectangle represents the doubled standard deviations.)

of mean slopes to be ·1145, and Diagram XXXVI illustrates the relationship graphically. The regression line of health on age in years is:

$$\frac{\text{Deviation in Health from Mean Health}}{\sigma_h} = \cdot 01977 \times (\text{Age} - 29\cdot 065).$$

Thus, if we take σ_h, the standard deviation of health, to be 100 units as before, a year longer life means after 29 years of age a loss of about 2 units of health. Thus a woman in normal health at 29 is on the average 77·4 units of health above the border of 'Indifferent Health,' and it would require 39 years of 'aging' at the above rate to reduce her to 'Indifferent Health,' i.e. she would be 68 years of age. In other words, the failure of health with the working mother as she grows older, is a slow process and there is no reason to think it more rapid in the working classes than in any other class. It is the gradual physical increase of unfitness which follows in all characters after the human prime*.

We now turn to the relation of Mother's Health to the Number of Children. We have the following table:

TABLE XCVII.

Mother's Health	Number of Children																Totals
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Very Good and Good	327	234	154	137	92	72	79	31	23	15	4	8	2	2	1	—	1181
Indifferent	40	50	32	25	20	19	15	9	4	3	1	1	—	1	1	1	222
Poor	28	19	15	7	14	6	6	4	4	1	—	—	—	—	—	—	104
Totals	395	303	201	169	126	97	100	44	31	19	5	9	2	3	2	1	1507

Classing Indifferent and Poor Healths together the correlation by the biserial r method is $r = \cdot 0723 \pm \cdot 0243$, which is just significant.

For the regression line of health on number of children we have if C be number of children:

$$\frac{\text{Deviation from Mean Health}}{\sigma_h} = \cdot 0283 \times (C - 3\cdot 51).$$

Hence on the same supposition as before every additional child reduces the mother's health by 2·83 units of health, or since the average interval between children is about 2·6 years by about 1 unit per year. Owing to increase of age the woman's health falls about 2 units of health a year. It seems likely, therefore, that the association of mother's health and number of children is only a reflection of the effect of age on health.

Now we have the following correlations:

Mother's Health and Age	·1145
Mother's Age and Number of Children	·6798
Mother's Health and Number of Children	·0723

Partial Correlation of Mother's Health and the Number of her Children for Constant Age

$$= \frac{\cdot 0723 - \cdot 1145 \times \cdot 6798}{\sqrt{\{1 - (\cdot 1145)^2\}\{1 - (\cdot 6798)^2\}}}$$

$$= -\cdot 0075.$$

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* See *Biometrika*, Vol. I, p. 46, and Vol. IV, p. 53.

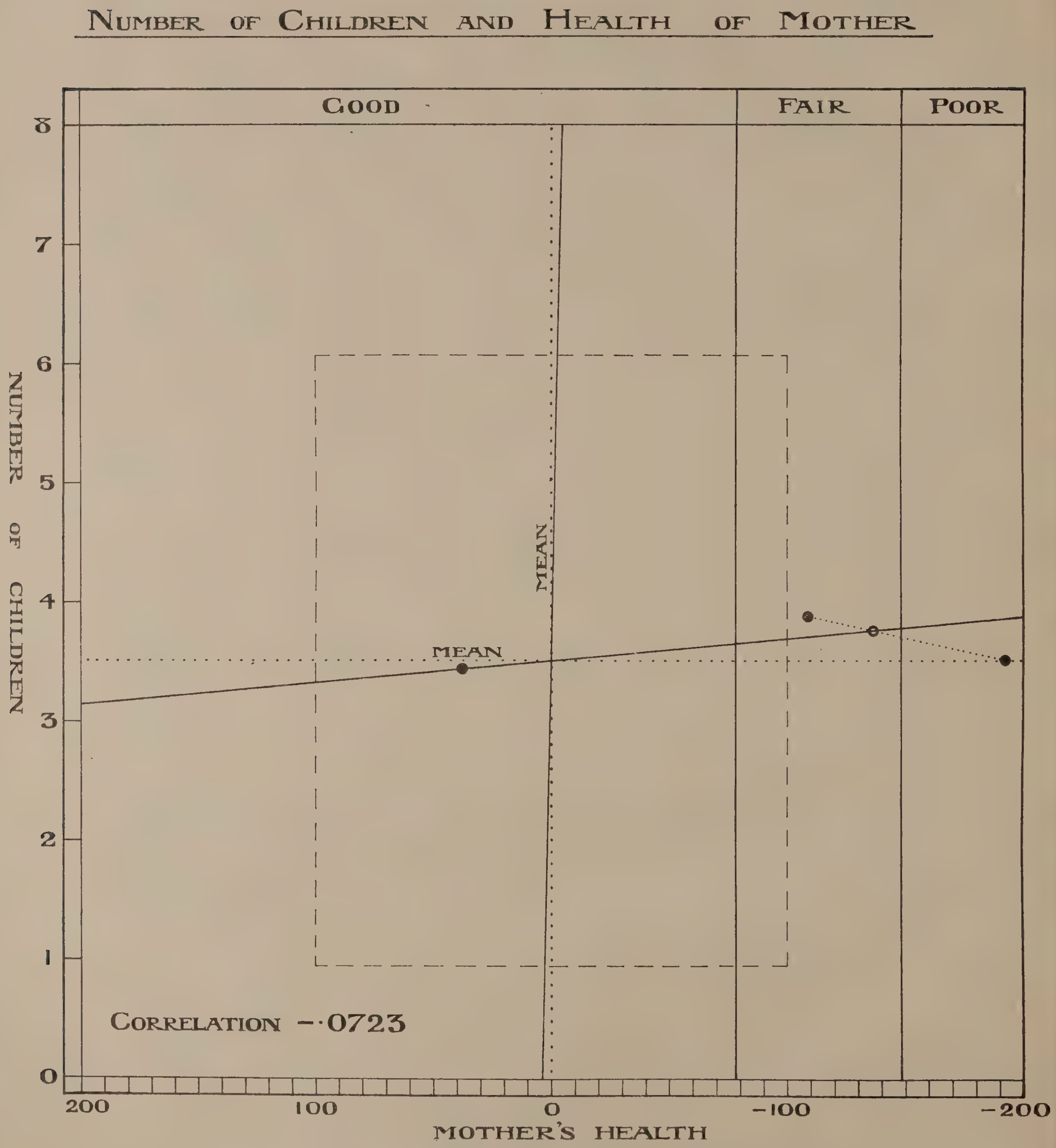

DIAGRAM XXXVII. (Rectangle represents the doubled standard deviations.)

The correlation is insignificant, but as it is negative, it would seem to indicate that if it were significant, out of two women of the same age the one with the more children will on the average be found the healthier.

There may be particular cases of harm arising to the wife from a large family, but our statistics in no manner support the view that the health of the wives of the working classes is on the average seriously injured by excessive child-bearing. On the other hand, we cannot argue from the above slight correlation that a large family promotes a woman's health. Even if the correlation were significant it might only be evidence that physically fitter women were physiologically—as from the eugenics standpoint one might hope—more fertile. Allowing, however, for age there is certainly no marked correlation between fertility and health.

Interrelated as these matters are—namely, employment of mother, mother's age, mother's health and the size of the family—the correlations are so low that we shall not be led into fallacy by neglecting them, when we now discuss the influence of Mother's Employment on Baby's Health. We shall, however, distinguish the various categories of Mother's Health as they are influential on Baby's Health.

TABLE XCVIII.

Baby's Health at a Year*	Mother's Health																				
	V. Good & Good					Anaemic					Indifferent					Poor					Grand Totals
	Home	Factory	Charing	No record	Totals	Home	Factory	Charing	No record	Totals	Home	Factory	Charing	No record	Totals	Home	Factory	Charing	No record	Totals	
V. Good & Good	403	98	34	110	645	27	9	—	—	36	53	20	7	17	97	25	11	3	5	44	822
Indifferent ...	31	11	6	13	61	4	1	1	1	7	18	4	1	8	31	12	1	—	3	16	115
Poor	71	19	8	16	114	5	1	—	2	8	24	4	2	1	31	6	—	2	4	12	165
Dead	67	20	7	24	118	2	3	1	—	6	17	5	5	11	38	12	3	2	5	22	184
Totals ...	572	148	55	163	938	38	14	2	3	57	112	33	15	37	197	55	15	7	17	94	1286

As before, we throw the Anaemic group in with those in Indifferent Health, although they have percentages nearer to the Good Health group. We then have the following table of percentages :

TABLE XCIX.

Percentages of Yearling Babies	Mother's Health								
	Good			Indifferent			Poor		
	Home Work	Out Work	Total Population†	Home Work	Out Work	Total Population†	Home Work	Out Work	Total Population†
In Good Health ...	70·5	65·0	68·8	53·3	56·3	52·4	45·5	63·6	46·8
In Poor Health ...	12·4	13·3	12·2	19·3	10·9	15·4	10·9	9·1	12·8
Dead	11·7	13·3	12·6	12·7	21·9	17·3	21·8	22·7	23·4
Death and Delicacy Rate	24·1	26·6	24·8	32·0	32·8	32·7	32·7	31·8	36·2

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* The classes of Baby's Health are I + II + III, IV, V, and VI of the scale given on p. 2.

† Percentages for the Total Population include the mothers without record of occupation and so do not necessarily give values lying between those for Home- and Out-workers.

Now the reader who studies Table XCIX attentively will see that it is not the Mother's Employment, but the Mother's Health, which substantially influences the Health of Baby at a year. In round numbers when Mother's Health is:

Good ... ... 25 % of babies die or are delicate and 69 % are in good health
Indifferent ... 33 % ,, ,, ,, 52 % ,, ,,
Poor ... ... 36 % ,, ,, ,, 47 % ,, ,,

a difference of 11 points in the Death and Delicacy rate and 22 in the Good Health rate. If the mother is in good health then

Homeworkers have 24 % dead and delicate babies and 70·5 % in good health
Outworkers ,, 27 % ,, ,, ,, 65·0 % ,, ,,

but the mothers in indifferent and poor health have sensibly the same Death and Delicacy rate, 32—33 %, whether they homework or outwork; the outworkers, however, of this group have a substantially higher Good Health rate among their babies!

Those who jump to conclusions might propound the paradox that it must be best for women of poor health to have outside work to do. There may be some element of truth in this, as the outside work may carry the mother more into the open air. But there is another aspect of the matter which we have found more definitely verified in fuller data yet to be published. Instead of asking what percentage of babies *born* will be in good health at the end of the year, let us ask what percentage of babies *living at the end of the year* will be in good health.

TABLE C. *Percentages of Yearling Babies in Good Health.*

Mother's Health	Home Occupation	Factory and Charing
Good	79·8 %	75·5 %
Indifferent ...	61·1 %	72·0 %
Poor	58·1 %	82·4 %

Those who merely pin their faith to superficial numbers might argue that the employed mothers in poor health have the greatest percentage of yearling babies in good health. So indeed they have! But it is because the poor health of the mother, and to a lesser extent her outside occupation, have killed off a larger number of the weakly babies in the course of the year. The mothers with only home occupations keep more of their babies alive with the result that they show a lesser percentage of babies in the highest grade of health at the end of the year. Even with the most efficient baby-clinics universally consulted we are unlikely to be successful in absolutely evading this law of natural selection, and if we do, it will probably still show its influence on the death rate at later years or on the general physique of the race. The moral clearly of such figures is that the women of good health should be the mothers of the future generation, and their percentage of living yearling babies who are in good health will be slightly raised if they have only home occupations. Their health, however, is the main point, not their occupation.

To bring more closely home to the reader the influence of occupation on the welfare of the baby we put down the three 'plural*' fourfold correlation tables for occupation of mother and health of baby.

TABLE CI.

Baby's Health	Mother's Health								
	Good			Indifferent			Poor		
	Home Work	Out Work	Totals	Home Work	Out Work	Totals	Home Work	Out Work	Totals
Good	403	132	535	80	36	116	25	14	39
Not Good ...	169	71	240	70	28	98	30	8	38
Totals ...	572	203	775	150	64	214	55	22	77

The correlations obtained by the tetrachoric method are:

Mother's Health ...	Good	Indifferent	Poor
Correlation	– ·0901 ± ·0427	– ·0444 ± ·0763	– ·2717 ± ·1218

These correlations confirm our previous percentage results; namely, that whereas the mothers of good health have slightly healthier babies when they are not employed outside the home, the mothers of indifferent and poor health have healthier babies when they are employed outside the home. The correlations are, however, all scarcely significant having regard to their probable errors, and we are compelled to conclude that employment of the mother is not a seriously detrimental factor in infant welfare.

We can test these results by comparing the weights of babies at 13—14 weeks and the weights of yearling babies according to the employment of the mother. This method, however, has the disadvantage of disregarding the number of dead babies whom we have included in the health returns†.

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* See *Biometrika*, Vol. IX, p. 289.

† Without regard to Mother's Health the death rates for the first year of life are:

Home Mothers 12·6 °/o   Factory Mothers 14·8 °/o   Charing Mothers 19·0 °/o

The Delicacy rates are:

Home Mothers 13·6 °/o   Factory Mothers 11·4 °/o   Charing Mothers 15·2 °/o

giving respectively 26·2 °/o, 26·2 °/o and 34·2 °/o for the Death and Delicacy rates, there being no distinction in this rate between Home and Factory occupation. It is the Charing Mothers who show the appreciably worse result both in the Death and the Delicacy rates.

TABLE CII. *Mother's Employment before Confinement and Weight of Baby at 13 and 14 weeks.*

Weight in lbs.	Boys				Girls			
	Home	Charing	Factory	Totals	Home	Charing	Factory	Totals
4·4688	—	—	2	2	—	—	—	0
5·4688	3	—	3	6	2	3	1	6
6·4688	4	1	1	6	15	1	3	19
7·4688	12	1	5	18	10	4	1	15
8·4688	15	4	9	28	27	2	4	33
9·4688	18	3	12	33	28	5	4	37
10·4688	24	3	8	35	38	5	14	57
11·4688	37	—	12	49	40	2	15	57
12·4688	44	1	10	55	52	2	8	62
13·4688	34	6	8	48	22	5	2	29
14·4688	17	2	6	25	8	1	1	10
15·4688	8	—	1	9	5	1	—	6
16·4688	7	—	1	8	—	—	—	0
17·4688	5	—	—	5	—	—	—	0
18·4688	2	—	—	2	—	—	—	0
Totals ...	230	21	78	329	247	31	53	331

The means of the arrays are as follows:

TABLE CIII. *Weights in lbs.*

	Boys	Girls
Total Population ...	11·4962	10·7226
Home Mothers ...	11·8297	10·8129
Factory Mothers ...	10·9450	10·1462
Charing Mothers ...	10·6611	10·6386

There is not much difference between the various groups in the case of girls, but the outworking mothers have male babies of about a pound less weight. If we form fourfold tables—

TABLE CIV.

Boys	Home-workers	Out-workers	Totals
Under 11·9 ...	113	64	177
11·9 and over ...	117	35	152
Totals	230	99	329

TABLE CV.

Girls	Home-workers	Out-workers	Totals
Under 10·97 ...	120	47	167
10·97 and over ...	127	37	164
Totals	247	84	331

—the correlations are $r = -{\cdot}2354 \pm {\cdot}0591$ and $r = -{\cdot}1093 \pm 0627$.

The mother's outwork is thus hardly significant in the case of female babies; it is significant but moderate in the case of male babies—the more outwork the less weight.

When we come to yearling babies, however, the correlation remains hardly significant in the case of girls, and becomes insignificant in the case of boys. As the weights of yearling babies cannot be given when they have died in the year, this suggests a process of selection. Turning to the yearling babies we have the following tables connecting Mother's Employment during Pregnancy and Weight of Yearling Babies:

TABLE CVI.

Mean Weight of Subrange in lbs.	Mother's Employment. Boys			Totals	Mother's Employment. Girls			Totals
	Home	Factory	Charing		Home	Factory	Charing	
8·4688	—	—	—	0	—	1	—	1
9·4688	—	—	—	0	1	—	—	1
10·4688	1	—	3	4	—	1	4	5
11·4688	1	3	—	4	9	3	1	13
12·4688	3	4	1	8	12	—	—	12
13·4688	9	5	2	16	23	4	2	29
14·4688	8	9	2	19	16	12	2	30
15·4688	27	5	—	32	23	8	1	32
16·4688	29	6	6	41	58	10	4	72
17·4688	53	9	8	70	39	19	7	65
18·4688	48	9	13	70	39	13	3	55
19·4688	53	20	4	77	41	3	7	51
20·4688	41	21	1	63	21	2	1	24
21·4688	31	13	1	45	9	5	2	16
22·4688	22	2	—	24	10	3	—	13
23·4688	11	8	—	19	4	—	—	4
24·4688	5	5	—	10	3	—	—	3
25·4688	7	2	—	9	—	—	—	0
26·4688	2	—	—	2	—	—	—	0
27·4688	1	1	—	2	—	—	—	0
28·4688	1	—	—	1	—	—	—	0
Totals ...	353	122	41	516	308	84	34	426

The means of the arrays are as follows:

TABLE CVII.

	Boys	Girls
Total Population ...	18·8254	17·1660
Home Mothers ...	18·9872	17·3032
Factory Mothers ...	18·8254	16·8498
Charing Mothers ...	17·0298	16·7041

We note again the sexual difference. There is no significant difference between Home and Factory Mothers in the case of boys, but about 7·5 ozs. in the case of girls. While in the case of girls Charing Mothers and Factory Mothers are about alike, in the case of boys it is the Charing Mothers, not the Factory Mothers, who do badly. The general relationship may be obtained from the following fourfold tables:

TABLE CVIII.

Weight in lbs.	Mother's Employment. Boys			Weight in lbs.	Mother's Employment. Girls		
	Home	Outwork	Totals		Home	Outwork	Totals
Under 18·9688	179	85	264	Under 17·9688	181	79	260
Over 18·9688	174	78	252	Over 17·9688	127	39	166
Totals ...	353	163	516	Totals ...	308	118	426

The correlations thus determined are:

Boys ... $r = -·0229 \pm ·0486$
Girls ... $r = -·1288 \pm ·0549$

We see that the correlation in the case of the boys is not significant; in the case of the girls is small but probably just significant. The correlations, as we might expect, are less than those of Mother's Employment and Baby's Health.

We really have not data ample enough for analysing successfully these small associations. Still, the question of charing for the pregnant woman wants careful watching. The mean weight of both boy and girl babies of Charing Mothers is unsatisfactory, but it must be noted in this respect that the mother who does charing is above the average mother in age, is below the average mother in health and comes from a home economically below the average. These may be the factors upon which the influence on baby's health and weight depends rather than the charing itself. It would be quite feasible to determine this if only the data were more copious.

(*f*) *Sleeping Conditions.* A great deal of stress has been laid on the necessity for a separate cradle for the baby. We have information as to the sleeping conditions of 1738 babies. The following is the table, which combines both sexes:

TABLE CIX.

Health of Baby	Nature of Sleeping Locus			Totals
	With Parents	With Parents or in Cradle	In Cradle	
I Very Satisfactory ...	32	1	17	50
II Satisfactory	278	14	123	415
III Normal	457	19	154	630
IV Indifferent	137	2	38	177
V Unsatisfactory ...	188	7	64	259
VI Dead	149	8	50	207
Totals	1241	51	446	1738

Thus in a great town in the North of England 71·4 °/₀ of babies use no cradle, 25·7 °/₀ invariably use the cradle and 2·9 °/₀ have a cradle but do not always use it. Thus nearly three-quarters of the population have not yet reached the level of what seems so ancient, cradle-culture, but still persist in that earlier state in which the baby was kept for a long period in personal contact with the mother.

The Death and Delicacy Rates, etc., are given below:

TABLE CX. *Percentages of Yearling Babies.*

	Cradle	Part Cradle	With Parents
In Satisfactory Health	31·4 °/。	29·4 °/。	25·0 °/。
In Delicate Health	14·3 °/。	13·7 °/。	15·1 °/。
Dead	11·2 °/。	15·7 °/。	12·0 °/。
Combined Death and Delicacy Rate ...	25·5 °/。	29·4 °/。	27·1 °/。

We cannot lay much stress on the 'Part Cradle' as the numbers are so few, but the Cradle babies have small advantages in Death* and Delicacy Rates and a more considerable one in the Satisfactory Health Rate. Against it must, however, be put the fact that when babies are delicate they are much more likely to be restless, and a restless baby is more likely to be taken into her bed by the mother.

If we make a fourfold table we have:

TABLE CXI.

Baby's Health	Baby Sleeps		Totals
	In whole or part with Parent	Wholly alone	
Good (I, II, III)	801	294	1095
Not Good (IV, V, VI) ...	491	152	643
Totals	1292	446	1738

and find: $r = -\cdot 0621 \pm \cdot 0279$,

the baby sleeping alone having the better health.

We see that the correlation may be just significant, but it is of small intensity, or the use of the cradle is not a primary factor of infant welfare.

(*g*) *The Use of the Baby Pacifier or Comforter.* There is a very strong feeling about the danger of Baby Pacifiers, and a not very small section of medical authority has laid great stress on the evil of them. We do not know how far this stress has actual statistical evidence behind it, or is merely based upon the universal experience, which even the layman can obtain by a walk through the poorer streets. The comforter falls at worst into the gutter, at best into the bottom of a by no means cleanly perambulator, and is restored to baby's mouth, sometimes with a rub on a dirty apron, sometimes without. The death rate of babies using comforters treated in this way ought indeed to be high! We have returns of the health of 1265 babies with a record of the use of the comforter.

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* It would be of interest to know how far 'overlying' is the source of the one point greater death rate.

TABLE CXII.

Comforter	Baby's Health				Totals
	Good	Indifferent	Poor	Dead	
Used ...	464	83	115	107	769
Not used ...	372	39	73	12	496
Totals ...	836	122	188	119	1265

60·8 °/ₒ or the majority of babies are provided with comforters, and therefore the evil is very widespread. It would seem as if no babies ought to survive, if the evil be as great as observation would suggest.

Reduced to percentages our table runs:

TABLE CXIII. *Percentages of Health Classes.*

	Good	Indifferent	Poor	Dead
Using Comforter ...	60·3 °/ₒ	10·8 °/ₒ	14·9 °/ₒ	13·9 °/ₒ
Not using Comforter ...	75·0 °/ₒ	7·9 °/ₒ	14·7 °/ₒ	2·4 °/ₒ

If we take this table as one of causation 14·7 °/ₒ of babies lose their good health and 11·5 °/ₒ die from the use of the comforter!

Making a fourfold table we have:

TABLE CXIV.

Comforter	Baby's Health		Totals
	Good	Not Good	
Used ...	464	305	769
Not used ...	372	124	496
Totals ...	836	429	1265

providing us with the correlation:

$$r = -\cdot 2501 \pm \cdot 0298.$$

This if a moderate is a quite significant correlation. It is even large compared with those of any environmental factor we have yet come across.

But an association cannot be taken as a causation without further investigation. What if the Baby's Health were the cause of the comforter being used, and we were making the consequent the antecedent? What, again, if the baby were in bad health because its mother was in bad health, and mothers in bad health were apt to use any means in their power to keep the baby quiet?

We looked back at the baby's health when the first visit was at 14 or less days, and therefore before the comforter was used, and found the following result:

TABLE CXV.

Babies who later in life	Babies less than 14 days old	
	Good Health	Indifferent or Poor Health
Used a Comforter	71·8 °/。	28·2 °/。
Did not use a Comforter ...	91·9 °/。	8·1 °/。

Thus the babies who in *later* life used a comforter had 20 °/。 less of Good Health and 20 °/。 more of Indifferent and Poor Health than those who in later life did not use a comforter! In other words, the group who used a comforter later had their bad health in anticipation of its use, or the bad health was the antecedent and the comforter the consequent!

The correlation between baby's health and comforter before its use is $-·47 \pm ·08$. There is thus in all probability a greater association between baby's health and the comforter before its use than after its use. In other words, *a comforter is a better indication of what a baby's health has been than what it is.* It may be retained after the excuse for using it has disappeared.

It seemed worth while pressing the matter further and inquiring what relation the comforter has to the health of the mother. We have the following table:

TABLE CXVI.

Baby	Mother's Health			Totals
	Good	Indifferent	Poor	
Uses Comforter	652	172	78	902
Does not use Comforter ...	473	95	19	587
Totals	1125	267	97	1489

There is clearly a correlation here between Mother's Health and the use of the comforter, as may be seen from the following percentages:

TABLE CXVII.

Comforter	Mother's Health		
	Good	Indifferent	Poor
Used ...	72·3 °/。	19·1 °/。	8·6 °/。
Not used ...	80·6 °/。	16·2 °/。	3·2 °/。

The mother has not quite three times as much poor health when she lets her baby have a comforter. Are we to say that the comforter causes the bad health of the mother? Yet the argument is as logical as to make the comforter the source of bad health in the baby!

The fourfold table is:

TABLE CXVIII.

Comforter	Mother's Health		
	Good	Not Good	Totals
Used ...	652	250	902
Not used ...	473	114	587
Totals ...	1125	364	1489

leading to $r = -\cdot 1662 \pm \cdot 0298$.

Or, if we were to interpret the comforter as causative, the influence of the comforter on the mother's health would be two-thirds of that on the baby's health. We should not be surprised to find it slightly related to the Father's Health! The correlation merely indicates of course that when mothers are in poor health they not only have delicate babies, but that parents in poor health will take the readiest means of pacifying their infants. For the same reason we should expect to find the use of sedatives for the baby associated with mother's health.

Thus, as far as the present statistics are concerned, we have not been able to trace any marked influence of the comforter. Whatever influence it may have is screened by the selection of the babies on the one hand and the mothers on the other who adopt it.

The method used here will be found convenient in many researches and save investigators from much fallacy, namely, when a treatment or factor is supposed to have a bad effect (or, of course, a good effect) on health to ascertain whether there has been a truly random selection of individuals to be treated and not treated, by correlating the treatment with health *before* its application as well as after.

7. INFLUENCE OF OTHER CHILDREN ON BABY'S HEALTH.

It has been suggested that a large family handicaps the later born, the mother is physically worn out by the work of attending to her home and children, and owing to the crowd the baby does not get adequate attention. We can find only moderate influence of size of family on the health of yearling babies. The mean health of baby seems to fall up to three or four other living children and then to rise somewhat, so that the regression curve is not linear; we have fitted it with a parabola, assuming a normal scale for health of baby.

The following are the fundamental tables:

Table CXIX.

Number of other Living Children	Health Categories*													
	Boys							Girls						
	I	II	III	IV	V	VI	Totals	I	II	III	IV	V	VI	Totals
0	15	78	119	28	43	44	327	9	55	120	27	19	26	256
1	7	60	74	24	29	21	215	5	44	73	14	33	28	197
2	8	34	50	15	30	20	157	4	31	45	16	20	13	129
3	1	16	26	14	22	11	90	—	24	34	15	13	14	100
4	2	16	26	8	16	8	76	—	14	22	4	13	8	61
5	1	8	12	3	8	5	37	—	9	13	7	9	6	44
6	—	4	6	1	—	4	15	—	7	6	—	3	3	19
7	—	5	2	2	—	1	10	—	5	2	—	—	—	7
8	—	4	1	1	1	—	7	—	—	1	—	1	—	2
9	—	—	1	2	—	1	4	—	1	1	—	1	—	3
10	—	—	1	—	—	—	1	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	1	—	—	—	1	—	—	—	—	—	—	—
Totals ...	34	225	319	98	149	115	940	18	190	317	83	112	98	818

The mean healths of the babies having 0, 1, 2, 3, 4, 5 and 6—13 living siblings were found, treating Category III as common standard of reference, and supposing the mean of each array to be determinable on the assumption that the distribution is normal. Diagram XXXVIII gives the results. The following table provides the chief constants, η being the correlation ratio of health on number of living siblings of baby:

Table CXX.

	Boys	Girls
Mean of Siblings	1·6628	1·7421
Standard Deviation of Siblings	1·8408	1·7844
Correlation Coefficient ...	$-\cdot0564 \pm \cdot0219$	$-\cdot0617 \pm \cdot0235$
Correlation Ratio	$\cdot1409 \pm \cdot0216$	$\cdot0877 \pm \cdot0234$

The equations to the regression parabolae are:

$$\textit{Boys:}\ \frac{\text{Deviation from Mean Health}}{\sigma_h} = -\cdot0058 - \cdot0676S + \cdot0107S^2,$$

$$\textit{Girls:}\ \frac{\text{Deviation from Mean Health}}{\sigma_h} = \cdot125 - \cdot1431S + \cdot0203S^2,$$

where S is the number of living siblings of baby.

If we assume σ_h to be 100 units of health the difference between no siblings and 10 living siblings would *raise* the health of girls about 60 and boys about 40 units, the greater number of siblings corresponding to better health. We have, however, no

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* See p. 2.

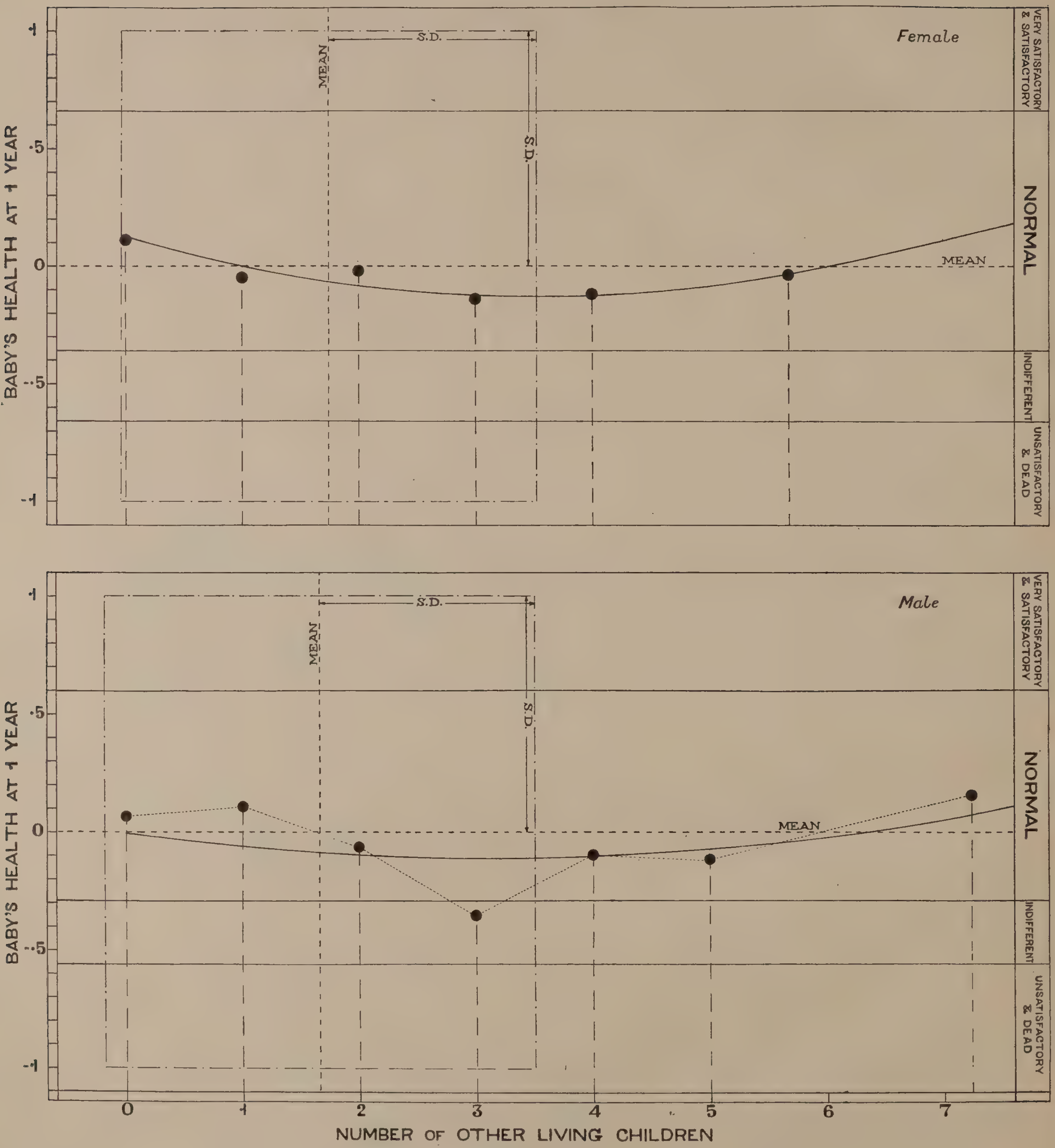

Diagram XXXVIII. Health of Baby and Number of other Living Children.
(Rectangles represent the doubled standard deviations.)

adequate data to test beyond 6 or 7 living siblings, and the diagrams show that, smoothing out the random variations, 10 units of health plus or minus are about the maximum variation due to size of family, and this is not an important amount on the health scale.

Somewhat different from the number of living children is the effect of the order of pregnancy. The following tables* give the influence of the number of the pregnancy on health of yearling babies:

TABLE CXXI.

Ordinal Number of Pregnancy	Health Categories													
	Boys							Girls						
	I	II	III	IV	V	VI	Totals	I	II	III	IV	V	VI	Totals
1	14	63	98	21	30	35	261	8	36	96	20	12	18	190
2	6	47	61	21	29	15	179	4	36	70	15	27	15	167
3	4	38	41	11	22	18	134	3	28	34	9	16	13	103
4	6	20	29	12	16	12	95	1	23	31	16	15	14	100
5	2	20	19	5	18	9	73	1	19	30	9	12	12	83
6	—	11	26	4	9	8	58	—	14	20	6	8	12	60
7	1	7	11	7	12	8	46	—	14	18	5	11	6	54
8 and over	1	15	23	13	14	9	75	—	17	17	4	9	7	54
Totals ...	34	221	308	94	150	114	921	17	187	316	84	110	97	811

We have:

TABLE CXXII.

	Boys	Girls
Mean Order of Pregnancy ...	3·4104	3·5795
Standard Deviation of Pregnancies	2·5500	2·5017
Correlation Health and Order ...	− ·1312 ± ·0218	− ·0531 ± ·0236

In order to judge of the concentration of pregnancies we corrected these results for age of mother and found:

Correlation of Health of Baby and Order of Pregnancy for constant age of Mother:

Boys ... − ·1061 ± ·0220 Girls ... − ·0437 ± ·0236

Thus the influence of order of pregnancy is not simply due to the associated increased age of mother. It has a small influence in the case of girls and a somewhat greater influence in the case of boys, if corrected for age of mother.

Diagram XXXIX gives the graphical representation of the slight influence of order of pregnancy on male babies, and the practically negligible influence in the case of female babies.

The percentages are owing to the smallness of our series erratic, so that we are obliged in order to show the drift of the influence to group in big classes. Perhaps that adopted in the table below is the most suggestive grouping.

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* Condensed from the actual working tables

TABLE CXXIII.

Yearling Babies*		Ordinal Number of Pregnancy					All
		1st	2nd and 3rd	4th and 5th	6th and 7th	8th and over	
Boys	Death and Delicacy ...	24·9 °/o	26·8 °/o	32·7 °/o	35·2 °/o	30·7 °/o	28·7 °/o
	Good Health	29·5 °/o	30·4 °/o	28·6 °/o	18·3 °/o	21·3 °/o	27·7 °/o
Girls	Death and Delicacy ...	15·8 °/o	26·3 °/o	29·0 °/o	32·5 °/o	29·6 °/o	25·5 °/o
	Good Health	23·2 °/o	26·3 °/o	24·0 °/o	24·6 °/o	31·5 °/o	25·2 °/o

The rates especially in the girls do not run very smoothly, but the death rates do indicate an increase with the higher order of pregnancy, though they appear to reach a maximum with the 6th and 7th and then fall out. The Good Health rate in the boys is higher up to the 5th than it is for the 6th and beyond. The Good Health rate for the girls appears to be highest for the 8th and higher pregnancy, but the rate is not smooth. In the case of both boys and girls the 8th and higher pregnancies seem associated with better health than the 6th and 7th. An attempt to deal with the higher pregnancies by clubbing boys and girls together gave the following:

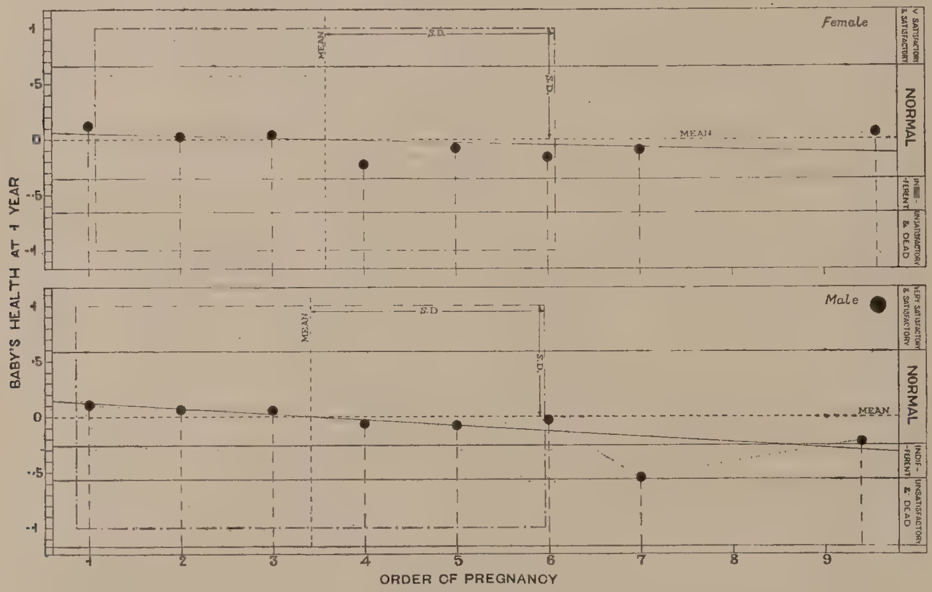

DIAGRAM XXXIX. Order of Pregnancy and Baby's Health at a Year. (Rectangles represent the doubled standard deviations.)

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* The Death and Delicacy percentage is that of Classes V and VI; the Good Health rate that of Classes I and II.

TABLE CXXIV.

Number of Pregnancy	6th & 7th	8th & 9th	10th & 11th	12th to 19th
Death and Delicacy Rate ...	35·6 °/o	28·2 °/o	25·8 °/o	40·0 °/o
Good Health Rate* ...	55·3 °/o	63·5 °/o	51·6 °/o	33·3 °/o

This does little more than indicate that the extent of our material is inadequate to bring out the slight influence of order of pregnancy on the health of the baby born when we analyse the higher pregnancies. There is need for a good deal more work on this point, especially for returns as to influence of age of mother combined with order of pregnancy, but it seems of little service to spend more energy over the matter until ampler data are forthcoming†. There is, however, one further point associated with this matter worth studying. How far is the mother's age apart from the number of pregnancies a source of poor health in the baby?

The following tables‡ associate the Health of Yearling Babies with Mother's Age at birth of Baby:

TABLE CXXV.

Age of Mother	Health of Yearling Babies													
	Boys							Girls						
	I	II	III	IV	V	VI	Totals	I	II	III	IV	V	VI	Totals
19 and 20	1	7	20	6	4	4	42	2	8	9	1	4	3	27
21 „ 22	4	26	30	13	19	17	109	2	22	37	6	5	10	82
23 „ 24	5	33	32	8	17	13	108	2	17	49	10	19	11	108
25 „ 26	5	30	42	12	23	12	124	3	16	51	11	12	12	105
27 „ 28	6	24	45	12	8	12	107	4	18	32	11	10	16	91
29 „ 30	3	28	31	9	13	10	94	1	23	35	12	8	11	90
31 „ 32	3	17	28	5	9	12	74	2	21	28	10	11	5	77
33 „ 34	2	14	20	6	21	10	73	1	12	22	6	9	6	56
35 „ 36	2	17	22	5	14	7	67	—	20	23	8	15	2	68
37 „ 38	1	7	12	6	7	7	40	—	17	13	3	11	8	52
39 „ 40	1	3	12	6	4	5	31	—	5	8	1	2	7	23
41 to 46	—	3	11	3	8	4	29	—	7	5	2	2	3	19
Totals ...	33	209	305	91	147	113	898	17	186	312	81	108	94	798

TABLE CXXVI.

	Boys	Girls
Mean Age of Mothers	29·05 yrs.	29·39 yrs.
Standard Deviation of Age ...	5·9022 yrs.	5·6398 yrs.
Correlation of Mother's Age and Baby's Health ...	− ·0789 ± ·0224	− ·0311 ± ·0239

---

* Classes I, II and III together.

† The adoption of a common schedule for baby-clinics would be most helpful from this standpoint.

‡ Condensed from working tables. Mean of last group 42·52 years for boys and 42·21 for girls.

Thus these total correlations show a small slightly significant decrease of health in boy babies with mother's age and a slighter insignificant one with girl babies. See Diagram XL.

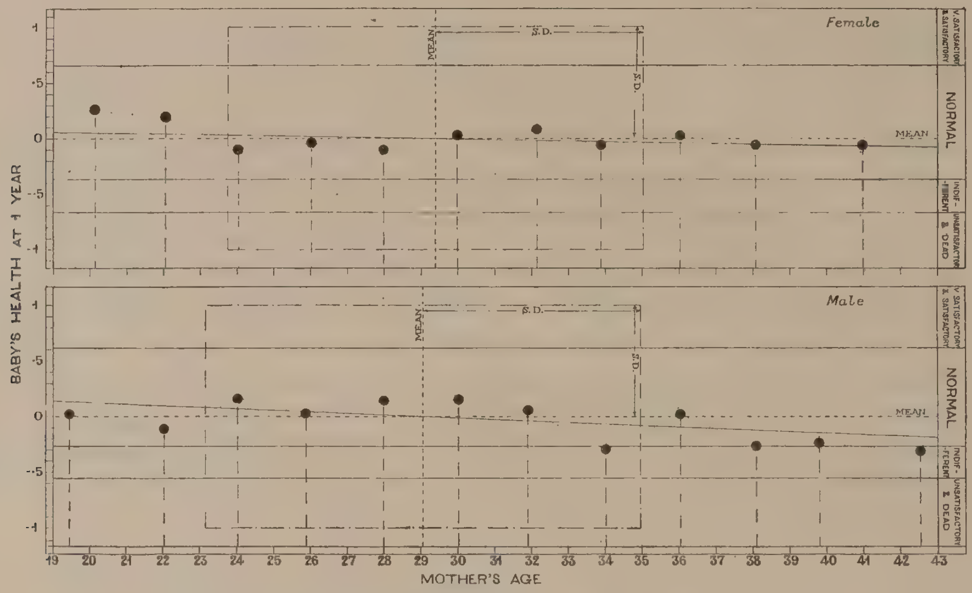

DIAGRAM XL. Mother's Age and Health of Yearling Babies. (Rectangles represent the doubled standard deviations.)

As Mother's Age might only denote that a greater or less number of pregnancies had occurred we found the partial correlation for Mother's Age and Health of Baby for a constant number of pregnancies. We have:

TABLE CXXVII.

Correlations	Boys	Girls
Baby's Health and Mother's Age	–·0789	–·0311
Mother's Age and Number of Pregnancies ...	+·6798	+·6798
Baby's Health and Number of Pregnancies ...	–·1312	–·0531
Correlation of Mother's Age and Health of Yearling Baby for a Constant Number of Pregnancies ...	+·0142 ± ·0225	+·0068 ± ·0239

Thus such slight correlation as exists between Mother's Age and Health of Baby is seen to be solely due to the older women having had more pregnancies. It is the Number of Pregnancies not the Age of Mother which is the factor producing the very slight decrease in health. The reader must remember that this is an *average* result; it is possible that the first pregnancy of an old mother may not be a factor making for infant health; we have not large enough numbers to test such a conclusion. It seems probable, however, that mothers from 24 to 32 have slightly healthier offspring than the mothers below 24 or above 32—at any rate in the case of boys, although in girls it does not look so like it. All we can say is that—however much the conclusion may run contrary to current impression—we can find in the present data no evidence that postponed marriage signifies feebler babies. The mother's age is only slightly influential on the health of her baby in that the product of a high order pregnancy is to a small extent less healthy than that of a low order pregnancy.

8. Influence of Parental Health on Baby's Health.

We now come to what is, perhaps, the most important phase of our subject: the influence of Mother's and Father's health on the health of their offspring. We have already dealt with some aspects of parental health. We have seen that the economic conditions of the home are more closely associated with the father's than the mother's health and interpreted this, in what we believe to be the true sense, that it is the father's physique which is causative in the condition of the home, and not the mother's health, which, by her longer occupation of the home, grows immune to bad (and of course to good) conditions*. The past evolutionary history of man suggests that he must be largely immune to bad habitational conditions, but that neither he nor his offspring are immune to *new* environmental conditions, whether they be those of a divergent civilisation or a non-familiar disease.

The following four tables give the associations between parental health and that of male and female yearling babies. We draw attention first to the fundamental difficulty of the problem.

We want to find the extent to which good health is inherited, but the parents' health is the health of an adult and the baby's health that of an infant. We do not know the extent to which the health of an infant is correlated with that of the same individual as an adult. And again we do know that many infants of poor health die in childhood and adolescence. Thus they fail to become parents. In other words the parents are a selected population. On both these grounds we might anticipate that the correlations will be weakened.

The natural method for finding the relative intensity of the relationship of parental

Table CXXVIII. *Correlation of Father's Health and Health of Yearling Baby.*

Father's Health	Boy's Health						Girl's Health					
	I+II	III	IV	V	VI	Totals	I+II	III	IV	V	VI	Totals
Strong	32	40	12	15	20	119	28	41	5	21	13	108
Good	86	121	32	51	50	340	60	123	30	32	39	284
Indifferent ...	4	11	5	8	7	35	6	8	3	5	3	25
Poor and Dead ...	8	11	5	14	6	44	12	17	11	11	6	57
Totals	130	183	54	88	83	538	106	189	49	69	61	474

---

* That Father's and Mother's Healths have considerable correlation (see p. 72) but are neither markedly correlated with environmental conditions is a fact to be borne in mind.

Table CXXIX. *Correlation of Mother's Health* and Health of Yearling Baby.*

Mother's Health	Boy's Health						Girl's Health					
	I+II	III	IV	V	VI	Totals	I+II	III	IV	V	VI	Totals
Strong	17	18	5	8	8	56	15	11	4	5	3	38
Good	183	220	55	83	72	613	152	229	46	73	53	553
Indifferent ...	41	53	22	38	20	174	31	48	22	19	22	142
Poor	13	29	13	15	14	84	11	25	13	11	16	76
Totals	254	320	95	144	114	927	209	313	85	108	94	809

and filial healths from these tables seems to be to proceed by finding the mean square contingency, deducing the mean square contingency coefficient and correcting for class-index correlation both ways. The results obtained were as follows:

Correlation of Father's Health and that of Male Baby: ·2004
„ „ „ „ Female Baby: ·2263
„ Mother's „ „ Male Baby: ·1794
„ „ „ „ Female Baby: ·2381

This would show correlations between parental and infantile healths fairly considerable in comparison with the environmental values thus far obtained. Unfortunately two of the corresponding mean square contingencies were actually less than the mean square contingency value for zero contingency, and the other two values differed less than their probable errors from it. In other words the values reached by this method, though, perhaps, justified by their accordance *inter se*, were not, taken individually, significant. We then proceeded to test these results in a variety of ways. In the first place we formed fourfold tables, grouping I, II, III of Baby's Health together, and Strong and Good of parents; we thus reached the following tables:

Table CXXX. *Father's Health and Infant's Health.*

Father's Health	Boys			Girls		
	I+II+III	IV+V+VI	Totals	I+II+III	IV+V+VI	Totals
Good	279	180	459	252	140	392
Not Good ...	34	45	79	43	39	82
Totals	313	225	538	295	179	474

Table CXXXI. *Mother's Health and Infant's Health.*

Mother's Health	Boys			Girls		
	I+II+III	IV+V+VI	Totals	I+II+III	IV+V+VI	Totals
Good	438	231	669	407	184	591
Not Good ...	136	122	258	115	103	218
Totals	574	353	927	522	287	809

---

* Mother's Health before pregnancy.

These led to the following values of the tetrachoric correlation*:

Correlation of Father's Health and that of Male Baby: ·1443 ± ·0557
,, ,, ,, ,, Female Baby: ·1442 ± ·0576
,, Mother's ,, ,, Male Baby: ·1961 ± ·0367
,, ,, ,, ,, Female Baby: ·2492 ± ·0391

The correlations of Mother's Health are now higher than those found for Father's Health as might reasonably be anticipated as the physical link is continued as long as the mother is suckling. These values in the case of the Father's Health are rather greater, and in the case of the Mother's Health considerably greater than we have found for most of the environmental factors we have so far been able to investigate. Thus Mother's Health has something like twice the influence of crowding, clothing, cleanliness, feeding, or economic conditions on the Baby's Health, and Father's Health is of the same or of slightly greater influence than these factors.

The matter is so important, and the double broad category table so difficult of exact quantitative determination, that we have approached it from quite a number of standpoints all of which it is not needful to reproduce here. One, however, we may consider, namely that which arises from determining the correlation ratio from a biserial dichotomy with the division between Baby's Health Groups III and IV. We have after correcting for the class-index of Father's Health†:

Correlation of Father's Health and that of Male Baby: ·1758 ± ·0282
,, ,, ,, ,, Female Baby: ·1299 ± ·0305
,, Mother's ,, ,, Male Baby: ·1705 ± ·0215
,, ,, ,, ,, Female Baby: ·2207 ± ·0225

Diagrams XLI and XLII are based on these values.

The values show that the Mother's Health before pregnancy is for the infant's welfare during the first year of life more influential than the Father's Health. We naturally ask whether this is an hereditary influence or is due to the close contact of mother and child during pregnancy. The following tables give the association of Mother's Health during pregnancy with the Health of yearling Babies:

CXXXII. *Mother's Health during Pregnancy and Health of Yearling Babies.*

Mother's Health During Pregnancy	Boys							Girls						
	I	II	III	IV	V	VI	Totals	I	II	III	IV	V	VI	Totals
Strong ...	1	5	6	—	2	1	15	1	8	4	1	1	3	18
Good ...	14	116	165	43	68	51	457	6	106	160	34	48	34	388
Indifferent ...	5	31	50	17	29	14	146	3	39	45	13	20	19	139
Poor ...	1	19	23	5	13	8	69	1	6	22	9	11	10	59
Totals ...	21	171	244	65	112	74	687	11	159	231	57	80	66	604

---

* From preliminary work in which we did not separate the sexes of the infants in order to increase our numbers we found for Infant's Health and Father's ·16 and Infant's Health and Mother's ·30.

† The objections to treating the arrays as normal in order to determine the means of the arrays are that it is only roughly approximate unless the arrays correspond to very small subranges, and that the means do not necessarily give a total mean corresponding to the means of the general population found from the marginal totals treated as normal. See, however, *Biometrika*, Vol. XIV, p. 152.

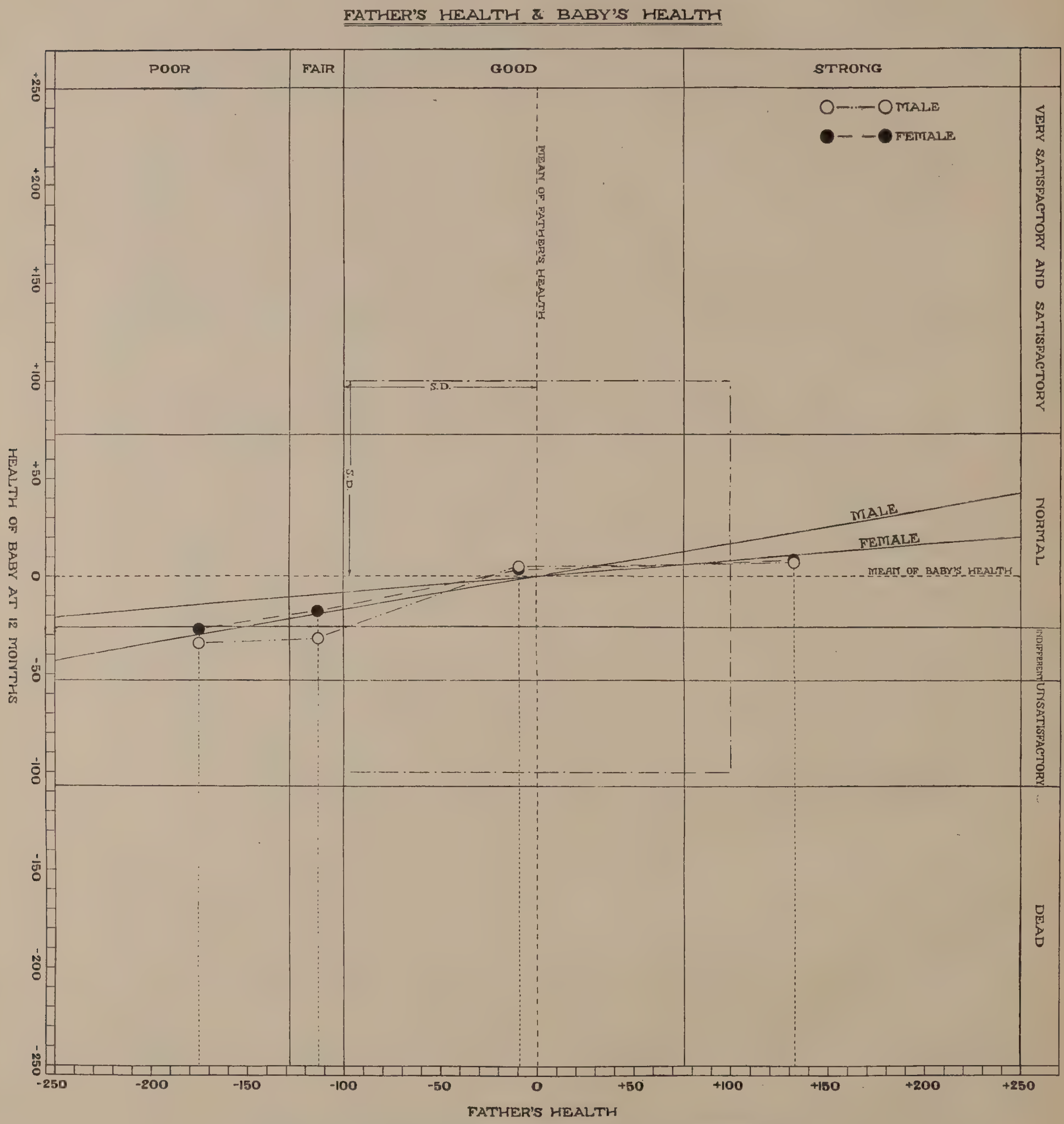

DIAGRAM XLI. (Rectangle represents the doubled standard deviations.)

MOTHER'S HEALTH & BABY'S HEALTH

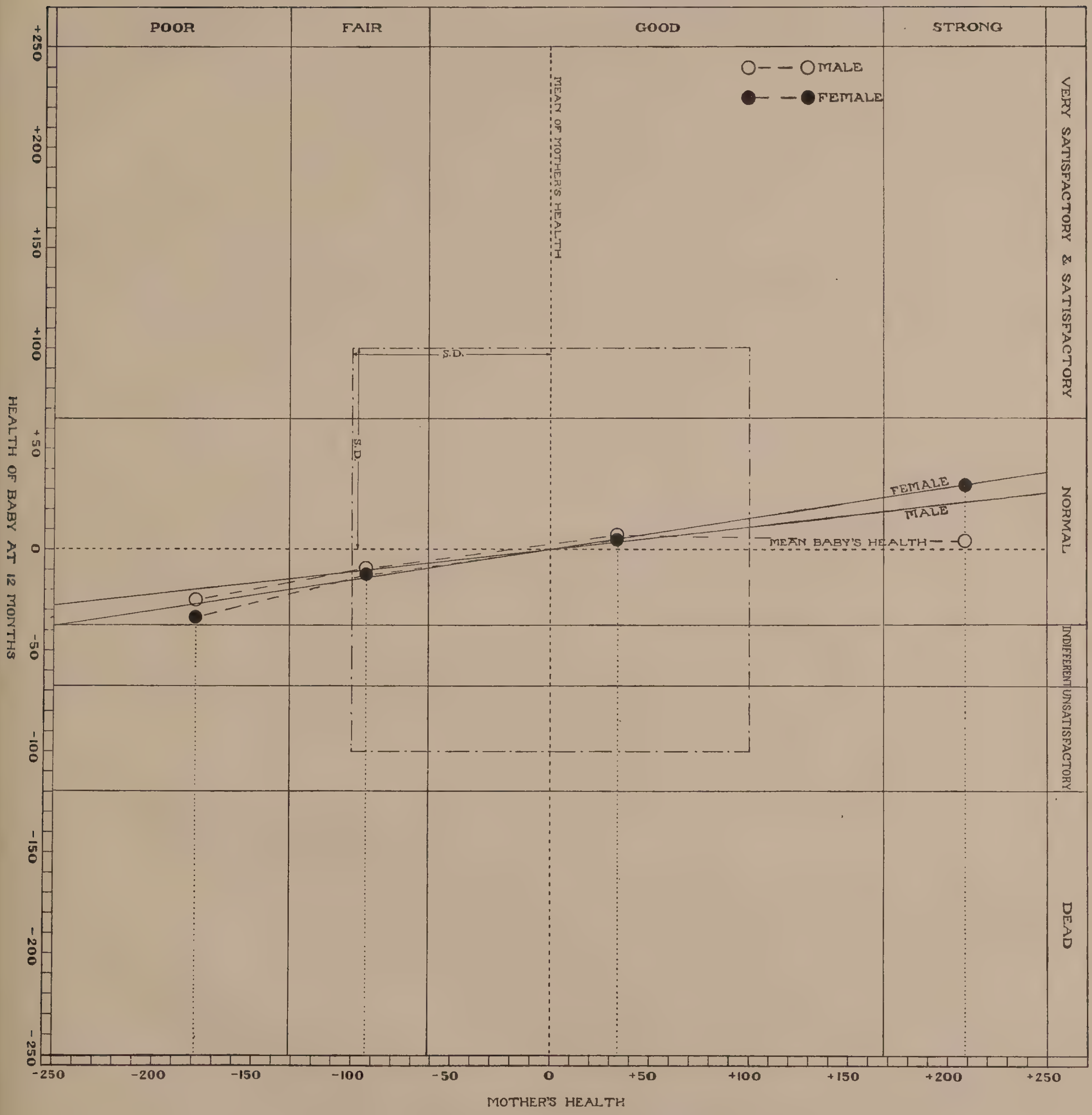

Diagram XLII. (Rectangle represents the doubled standard deviations.)

Treating the arrays of babies for categories of Mother's Healths as normal distributions to find the means and correcting for class-index of Mother's Health we have:

TABLE CXXXIII.

Boys	Girls
$r = \cdot0522 \pm \cdot0257$ $\eta = \cdot0712 \pm \cdot0256$	$r = \cdot1480 \pm \cdot0268$ $\eta = \cdot1577 \pm \cdot0268$

The correlation coefficients and correlation ratios* are in fair agreement, i.e. do not indicate marked deviation from linearity. The values are *less* than those found for Baby's Health and Mother's Health before Pregnancy by exactly the same processes, i.e.:

TABLE CXXXIV.

Boys	Girls
$r = \cdot1054 \pm \cdot0219$ $\eta = \cdot1409 \pm \cdot0217$	$r = \cdot1502 \pm \cdot0232$ $\eta = \cdot1764 \pm \cdot0230$

We will see if this be confirmed by the correlations obtained in the same manner from the fourfold tables. These are:

TABLE CXXXV.

Mother's Health during Pregnancy	Boy's Health			Girl's Health		
	I—III	IV—VI	Totals	I—III	IV—VI	Totals
Good	307	165	472	285	121	406
Not Good ...	129	86	215	116	82	198
Totals	436	251	687	401	203	604

The tetrachoric method gives:

Boys	Girls
$r = \cdot0887 \pm \cdot0429$	$r = \cdot1900 \pm \cdot0450$

compared with the correlations with mother's health before pregnancy of

$$r = \cdot1961 \pm \cdot0367 \text{ and } r = \cdot2492 \pm \cdot0391.$$

These results confirm previous ones, namely that the mother's health appears to have more influence on female babies than on male, and that mother's health before pregnancy is far more important than mother's health during pregnancy. We can carry this matter further by asking what is the relation between mother's health during pregnancy and the health of the yearling baby for constant health of the mother before pregnancy. We have:

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* Correlation ratios of Baby's Health on Mother's Health.

TABLE CXXXVI.

	Boys	Girls
Correlation of Baby's Health and Mother's Health before Pregnancy	·1961	·2492
Correlation of Baby's Health and Mother's Health during Pregnancy	·0887	·1900
Correlation of Mothers' Healths before and during Pregnancy ...	·7782	·7782

Partial Correlation Coefficient: *Boys* = – ·1037 ± ·0254
Girls = – ·0064 ± ·0274

The result for girls is non-significant; for boys it is significant. In both cases it is *negative*. It would thus appear that for women of constant health before pregnancy, the woman with the worse health during pregnancy has the child of better health. The result of this indicates that the health of a woman during pregnancy is only a sign of the health of her baby in that it is highly correlated with her health before pregnancy. However much discomfort or ill health during pregnancy there may be, if it be not an indication of bad health before pregnancy, there is little or no apparent detriment to the infant. If the woman is going to have a healthy baby, it probably means a big and active baby, and the resulting discomfort to the mother will be classed as 'bad health during pregnancy.' This is particularly the case with the male baby. The paradox therefore that for a mother of given health before pregnancy, the health during pregnancy will be worse the healthier the baby is not so inexplicable as it may seem, and the discomfort and ill health of some women during pregnancy may have their compensating advantages in a healthier boy born.

The correlations between Mother's Health before Pregnancy and Baby's Weight at a given age (partial correlation coefficient) are:

Boys: ·1140 Girls: ·1448

These are sensibly less than the correlations of Mother's Health before Pregnancy and Baby's Health at a year, indicating as we might anticipate that weight is only a partial index to the health of a baby. This suggests that we should proceed to determine the actual correlation between the Health and Weight of Yearling Babies. Tables CXXXVII and CXXXVIII give the available material.

These means show a steady decrease of weight in both boys and girls with decreasing health. We have found both η and r from the vertical arrays of the tables, and have provided Diagrams XLIII and XLIV illustrating the correlation both ways. We note that the variations in the weight of yearling babies are:

TABLE CXXXVII. *Health of Yearling Babies and their Weight.*

Weight in lbs.*	Health of Boy						Totals	Health of Girl						Totals
	I	II	III	IV	V	VI†		I	II	III	IV	V	VI†	
8—	—	—	—	—	—	—	0	—	—	—	—	1	—	1
9—	—	—	—	—	—	—	0	—	—	—	—	1	—	1
10—	—	—	—	—	4	—	4	—	—	—	4	3	—	7
11—	—	—	—	4	4	—	8	—	—	—	2	12	—	14
12—	—	1	2	1	2	3	9	—	—	2	1	7	—	10
13—	—	2	5	2	8	—	17	—	9	8	2	10	—	29
14—	—	—	7	3	11	—	21	—	2	15	14	9	—	40
15—	—	7	6	7	14	—	34	—	3	11	9	16	—	39
16—	—	15	12	10	9	—	46	—	21	29	9	17	—	76
17—	—	17	26	16	15	—	74	1	25	27	7	11	—	71
18—	—	21	38	5	15	—	79	4	18	30	5	6	—	63
19—	1	18	43	7	14	—	83	4	25	22	—	1	—	52
20—	3	18	36	7	7	—	71	3	8	14	3	—	—	28
21—	3	14	29	9	2	—	57	1	3	10	—	—	—	14
22—	—	10	14	3	—	—	27	—	6	3	—	—	—	9
23—	—	10	10	—	—	—	20	—	1	4	—	—	—	5
24—	—	8	2	—	—	—	10	—	2	1	—	—	—	3
25—	2	3	4	—	—	—	9	—	—	—	—	—	—	0
26—	—	1	1	—	—	—	2	—	—	—	—	—	—	0
27—	—	2	—	—	—	—	2	—	—	—	—	—	—	0
28—	—	1	—	—	—	—	1	—	—	—	—	—	—	0
Totals	9	148	235	74	105	3	574	13	123	176	56	94	0	462

From this table we deduce:

TABLE CXXXVIII.

	Boys	Girls
Mean Weight of Yearling Baby	18·803 lbs.	17·064 lbs.
Class I (Very Satisfactory)	21·802 „	19·392 „
Class II (Satisfactory)	19·867 „	18·160 „
Class III (Normal)	19·418 „	17·832 „
Class IV (Indifferent)	17·753 „	15·540 „
Classes V and VI (Unsatisfactory and Dead)	16·478 „	14·777 „

TABLE CXXXIX.

	Boys	Girls
Standard Deviation ...	3·0064 ± ·0599 lbs.	2·7456 ± ·0609 lbs.
Coefficient of Variation ...	15·99 ± ·33	16·09 ± ·36

Thus while the boys are absolutely more variable than the girls, relatively there is no significant difference in the variability of the weights of the two sexes.

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* The centre of the group 8— is at 8·4688 lbs.

† It is clear that only in a few exceptional cases a baby would be weighed in the 49th—55th week and be dead at the year record of health. For the purpose of finding array means the Dead (VI) are included with the 'Poor' Health.

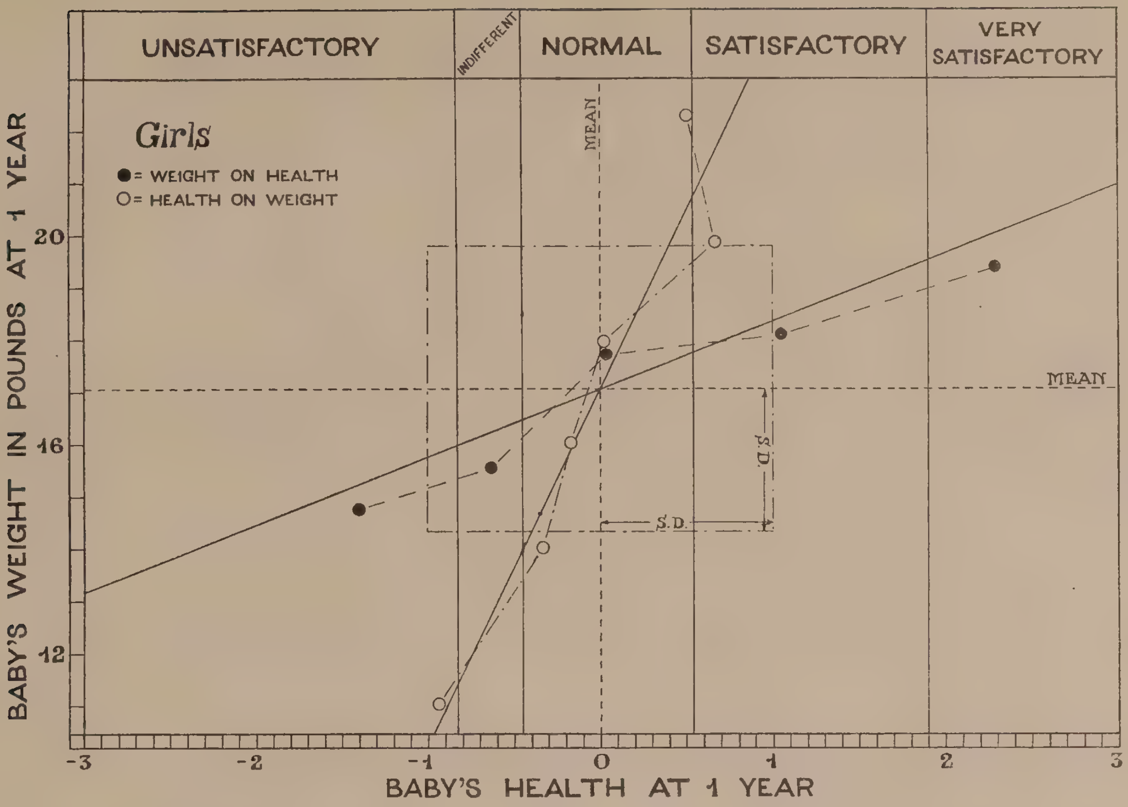

DIAGRAM XLIII. (Rectangle represents the doubled standard deviations.)

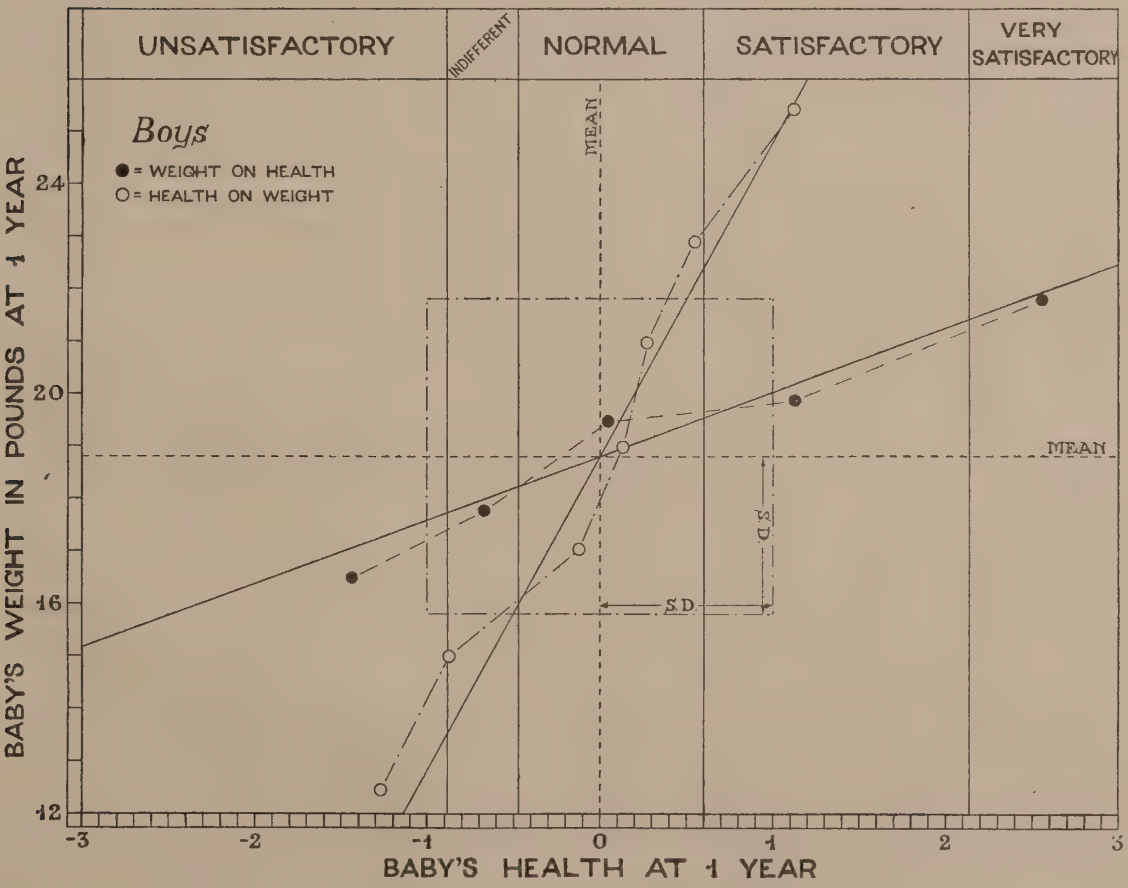

DIAGRAM XLIV. (Rectangle represents the doubled standard deviations.)

15—2

TABLE CXL. *Health and Weight of Yearling Babies.*

	Boys	Girls
Correlation Coefficient ...	$r = \cdot 4126 \pm \cdot 0233$	$r = \cdot 4769 \pm \cdot 0242$
Correlation Ratio ...	$\eta = \cdot 4684 \pm \cdot 0220$	$\eta = \cdot 5529 \pm \cdot 0218$

The correlations, moderately large, are probably not as large as those who lay great stress on weight as a measure of infantile health might anticipate. As we have frequently noticed in this memoir the correlation is more intense for the girls than the boys. The regression lines are, if w = weight:

$$\frac{\text{Deviation of Health from Mean}}{\text{Standard Deviation of Health}} = \overset{\text{Boys}}{\cdot 13724w - 2\cdot 5805}; \quad \overset{\text{Girls}}{= \cdot 17370w - 2\cdot 9640}$$

$$\overset{\text{Boys}}{\text{Probable Weight} = 18\cdot 803 + 1\cdot 2404} \times \frac{\text{Deviation of Health from Mean}}{\text{Standard Deviation of Health}};$$

$$\overset{\text{Girls}}{= 17\cdot 064 + 1\cdot 3094} \times \frac{\text{Deviation of Health from Mean}}{\text{Standard Deviation of Health}}.$$

9. RELATION OF AGE AND WEIGHT TO BABY'S HEALTH.

At the end of the last section we saw that the relation between the health of yearling babies and their weight, while considerable, was not so intense that weight was a very sure index to health. We have not seen, however, any charts in existence by which the inquirer could tell at a glance the probable grade of a baby's health from a knowledge of its weight at a given age. In England we have not only a mixture of races, but a variety of social classes, and almost each of these differs in average stature and weight. Thus a great variety of charts would really be needed, and it does not follow at all that a chart for a north-country manufacturing town and for the lower grade workers of that town could be satisfactorily applied to the babies of the London poorer classes, still less to the offspring of the professional classes. Our present charts are to be treated rather as samples of how such charts may be constructed, and not as final charts for the working class baby at large, still less for all babies. We have not data enough even for our limited district and class to obtain really adequate charts without a large amount of smoothing. We admit therefore their somewhat tentative character. Still we think they may be of value to those interested in baby-clinics and infant welfare centres*.

Their method of construction must now be considered, as well as the purposes for which they serve. One chart is for boys and one for girls. Either chart is entered with the age and weight of baby, and every infant thus corresponds to a definite point on the chart. Linking up these points for the same baby at different ages we obtain the growth in weight of that baby. This growth curve must be considered in relation to the *continuous* curve system which records for each age the percentage of

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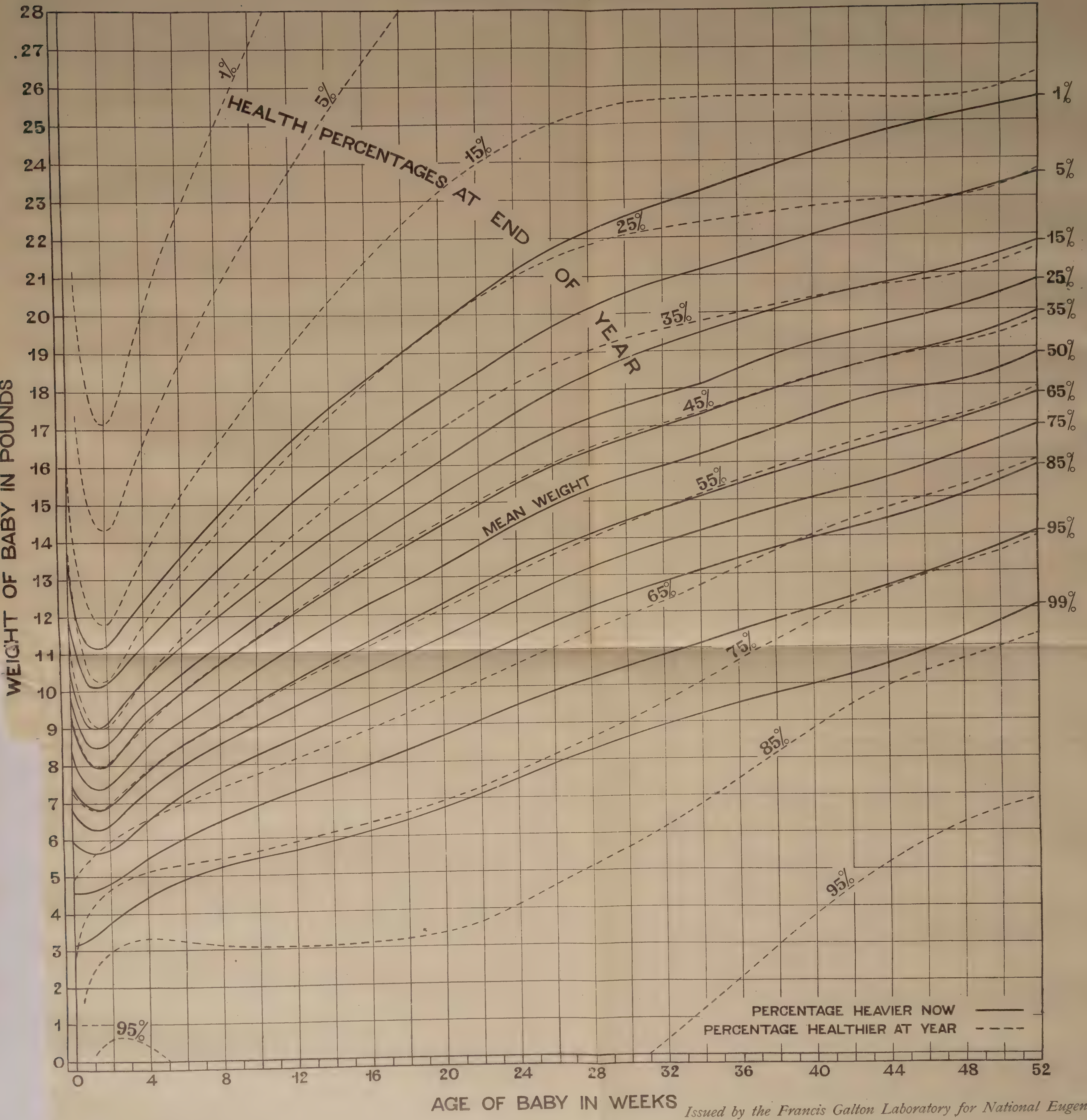
* They may be useful also to individual parents, who desire to plot weekly the weight of their infant and compare its grades with that of the general population of working class babies. This will indicate whether the baby is progressing, stationary or regressing. Map-mounted copies may be obtained from the Cambridge University Press, Fetter Lane, London.

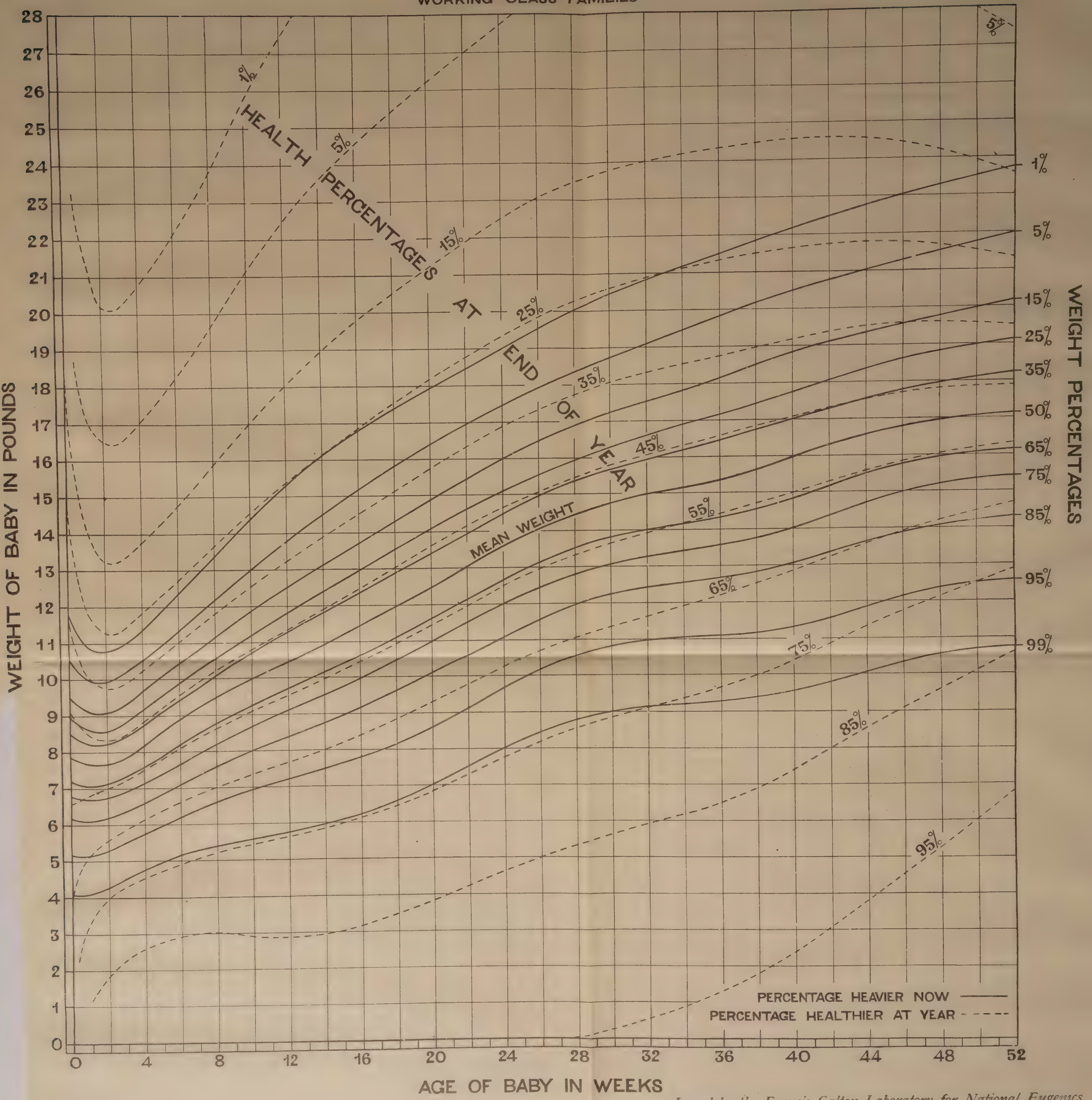
HEALTH & WEIGHT PROBABILITIES
MALE BABIES AT EACH AGE UP TO 52 WEEKS
WORKING CLASS FAMILIES



Issued by the Francis Galton Laboratory for National Eugenics.

Cambridge University Press, Fetter Lane, London.

HEALTH & WEIGHT PROBABILITIES
FEMALE BABIES AT EACH AGE UP TO 52 WEEKS
WORKING CLASS FAMILIES



Issued by the Francis Galton Laboratory for National Eugenics.

babies over a given weight. A baby which falls on the 50 °/₀ weight contour is an ordinary or mediocre baby, 50°/₀ of babies are heavier and 50 °/₀ lighter at that age. A baby which falls on the 5 °/₀ weight contour is a high grade baby, only 5 °/₀ of the population of babies are heavier; and one which falls on the 95 °/₀ contour is a low grade baby for 95 °/₀ of babies have greater weight, and this abnormally low weight at least suggests a need for special examination and treatment. These weight contours give the so-called weight grade of the baby and to that extent are a diagnosis of its immediate condition.

On the same charts, however, are given a second series of contours in broken lines. These are the health contours, and give the probable health grade of a baby of given age and given weight—not at that age, *but at the end of a year*. They form as far as is possible a prognosis of what a baby's health will be at the end of a year, based upon the weight of the baby at any age before the end of the year. Now as we have already indicated there is no very high, only a moderate, correlation between weight and health at a given age, there is still less correlation between weight at a given number of weeks and health at the end of the year. Still the possibility of some prognosis from immediate weight to future health seemed to us of considerable value, even though owing to the moderate correlation very high weights must be attained to predict that the health of the yearling baby will be extremely satisfactory, and very low weights much be reached to enable a person to predict that a given baby will have extremely unsatisfactory health, i.e. be probably dead at the end of the year. In order, however, to prevent over confidence on the one hand and excessive alarm on the other, we have avoided putting the health contours in the broad categories of our tables, such as very satisfactory, normal, poor, dead, etc. We have instead inserted the health grades. If the present weight, however, of a baby be such that its grade is as low as 80 °/₀ to 90 °/₀, i.e. that at a year 80 °/₀ to 90 °/₀ of babies will be healthier than the given baby, then its chance of survival, without special care and treatment, to the end of the year is small.

The first set of contours, as we have seen, gives the distribution of the weights of babies for each week of the first year of life. The data we had for such short periods being not too extensive, and exhibiting no marked skewness, it seemed far the most reasonable treatment to find the mean and standard deviation* of each array and then to determine the percentiles from tables of the probability integral, and plot therefrom the weekly means. The irregular series of points thus obtained was then smoothed by the aid of splines. The fall in weight in the first few weeks after birth was well marked, but owing to paucity of data is only approximately reliable. One point, however, was obvious, the babies of small weight do not lose much weight, it is the heavier babies who lose most; probably this arises from the fact that they have most to lose of what can be lost. It appears likely that a baby comes into the world with a certain redundancy of material as a provision against the days when its mother is only partially able to supply its needs, or it is itself learning its new method of life.

This fall in the weight of babies in the first fortnight of life appears to have been first noted by Chaussier in the first quarter of last century, and there is a considerable literature on the subject*. The actual mean weight curve for a given age in weeks may be obtained by any one of the following three processes :

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* The arrays are of course far from homoscedastic, just as the regression is far from linear.

(*a*) Smoothing with a celluloid spline† ;

GROWTH OF BABIES–MALE.

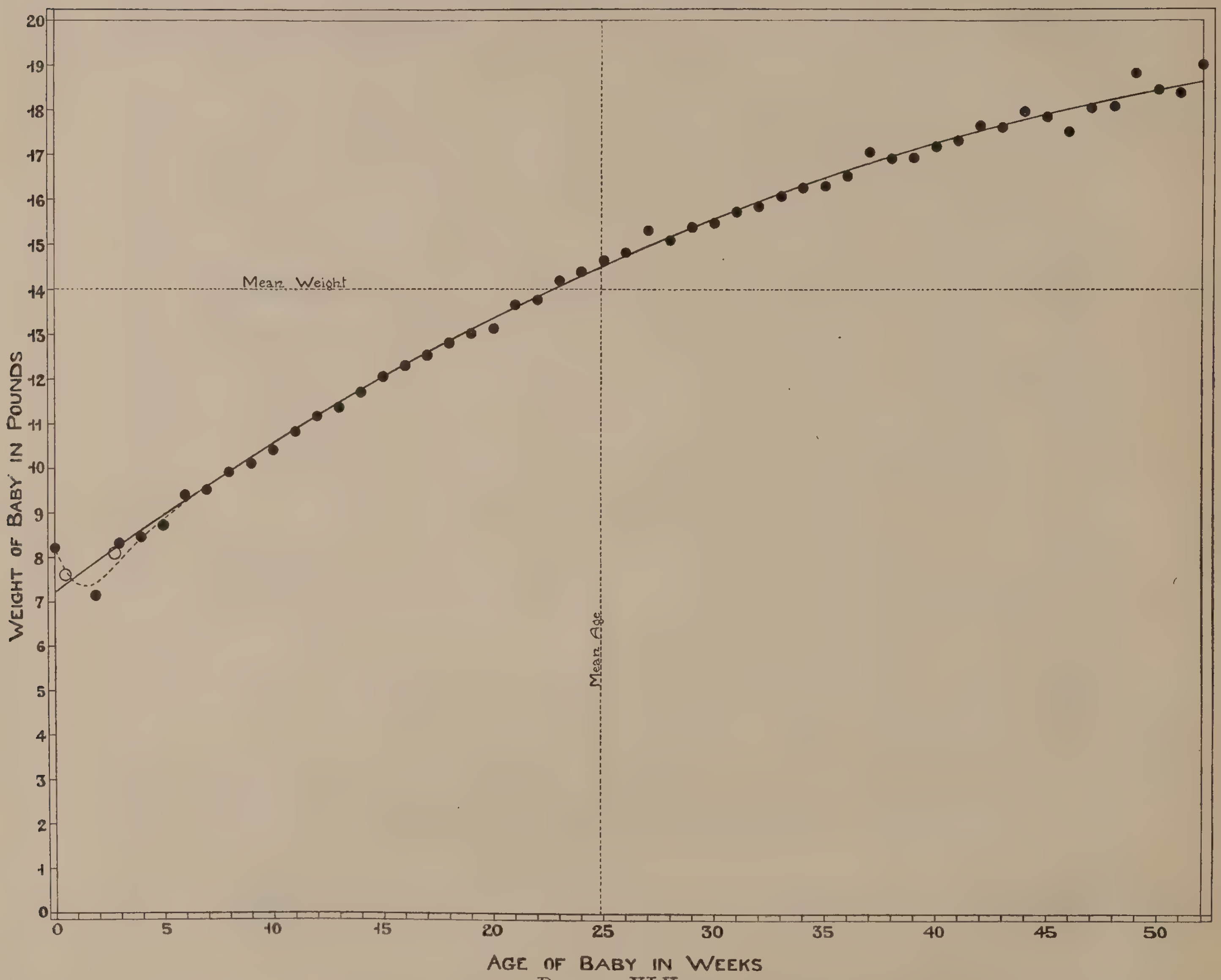

Diagram XLV.

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* A bibliography of this subject will be found in a paper published by G. Benestad, *Jahrbuch für Kinderheilkunde*, 1914, S. 21–41.

† A celluloid spline is better than the usual wooden spline, because the draughtsman can see through it and therefore balance better all points. The use of such celluloid splines was introduced by Karl Pearson when the staff of the Biometric Laboratory were working on high angle gunnery fire charts during the recent War. They were made up to a length of five feet, and of various thicknesses from $\frac{1}{10}$ inch upwards. They are provided with small cross-pieces at the terminals to keep them stretched on a rack when not in use. They form a valuable aid to the draughtsman and are used of course with 'Admiralty' weights like wooden splines. Ordinary precautions are requisite to see that they do not come in contact with open lights. Their advantages are transparency, flexibility combined with tenacity and cheapness as compared with the opaqueness, rigidity combined with brittleness and expense of long wooden splines.

(*b*) Smoothing by contiguous arcs*;

(*c*) Fitting with a cubic curve by least squares from weighted means.

We have used all these processes in the present investigation. (*c*) gives quite a good result, but it probably smooths out the variations due to vaccination and to the onset of teething, etc., which are indicated by (*b*). It is also not suitable for exhibiting the dip in the first fortnight of life. Accordingly (*b*) was used in Diagrams XLV and XLVI except in the first fortnight of life, when we had considerable irregularities demanding use of (*a*). In Diagrams XLIII and XLIV we indicate how close a result may be obtained from (*c*).

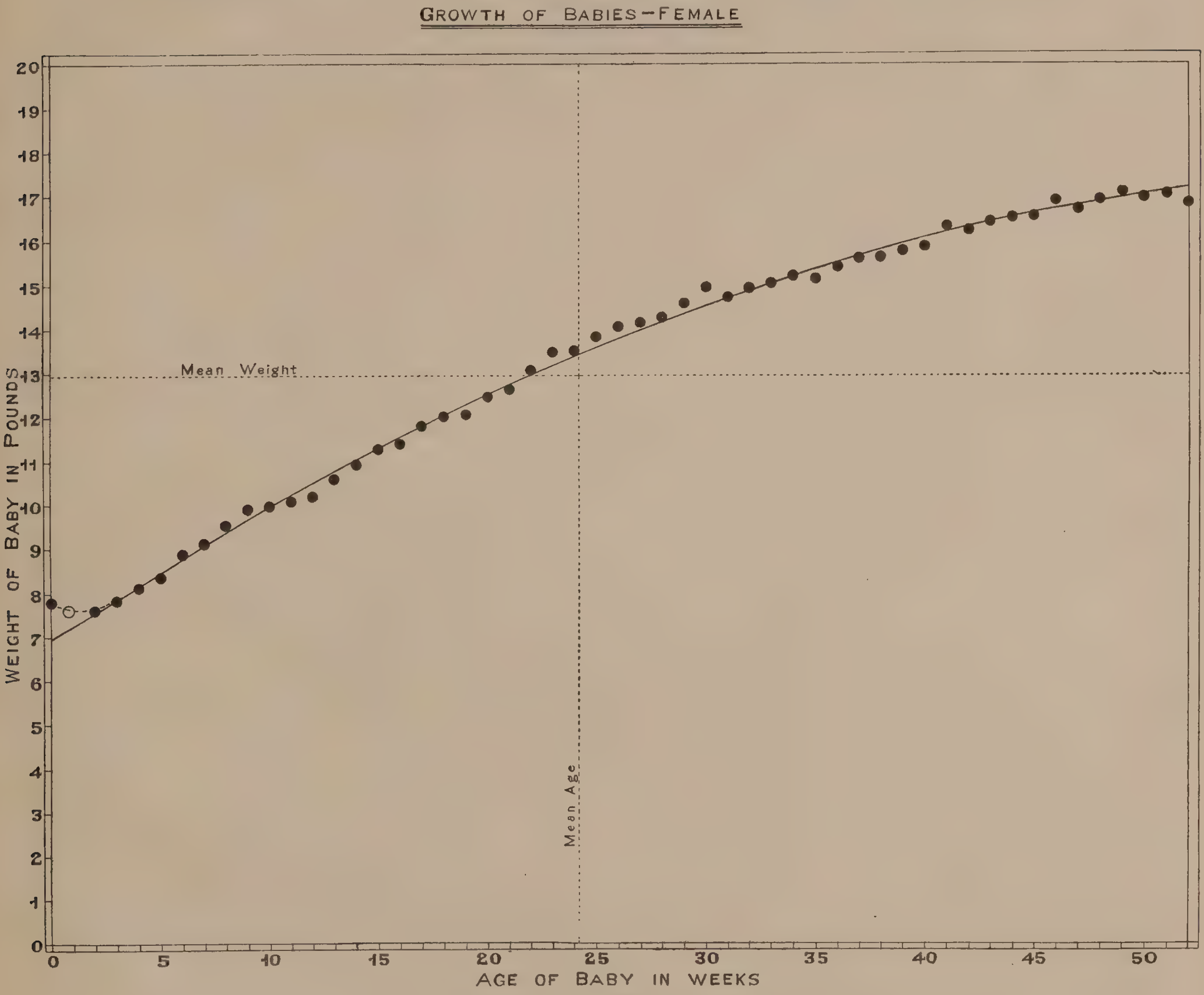

DIAGRAM XLVI.

Diagrams XLV and XLVI give the mean weight curves of babies of the given social

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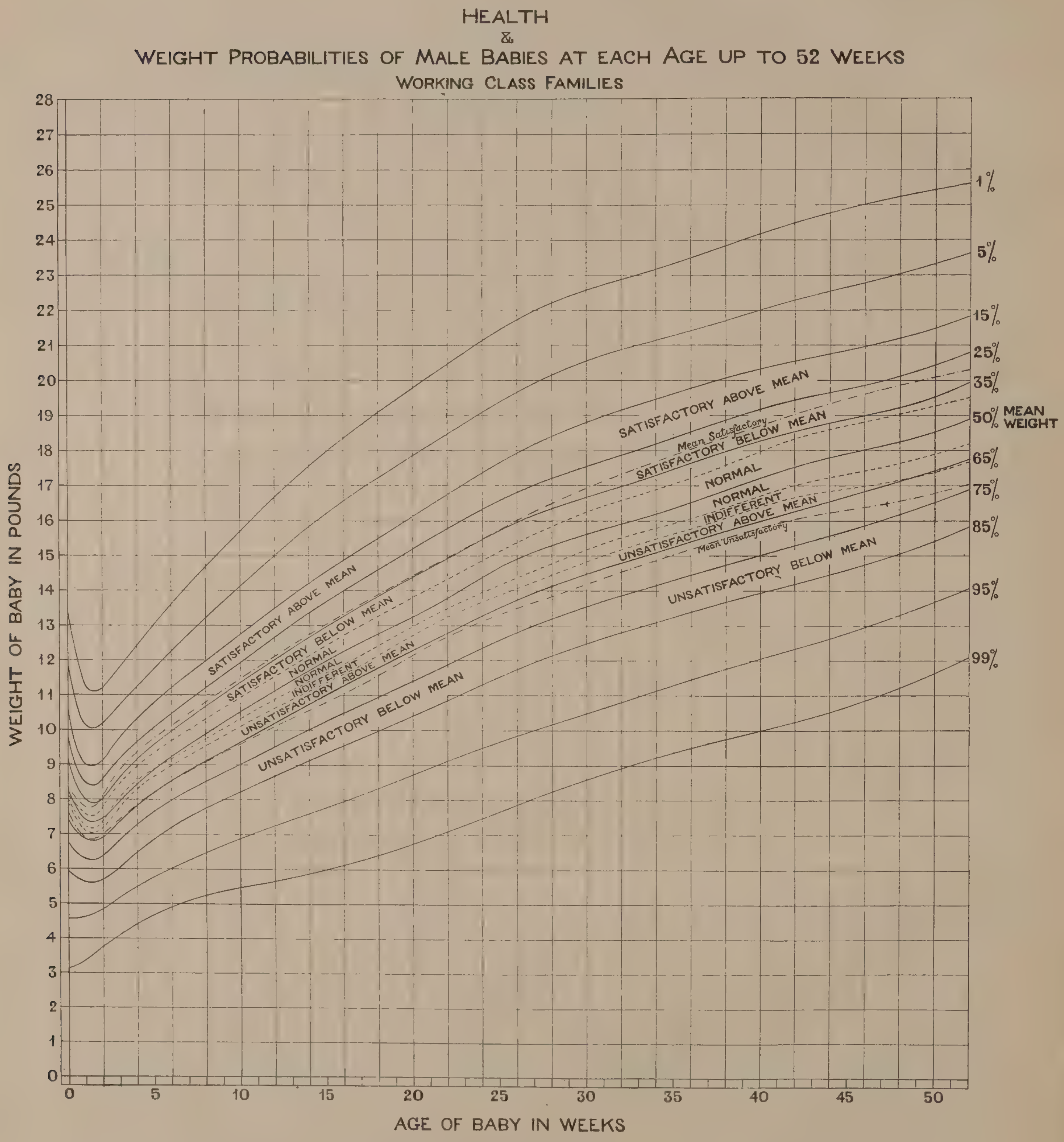
* E. C. Rhodes' process was adopted: see *Tracts for Computers*, VI (Cambridge University Press), *Smoothing*: p. 50 and Diagram IV.



HEALTH
&
WEIGHT PROBABILITIES OF MALE BABIES AT EACH AGE UP TO 52 WEEKS
WORKING CLASS FAMILIES

DIAGRAM XLVII.

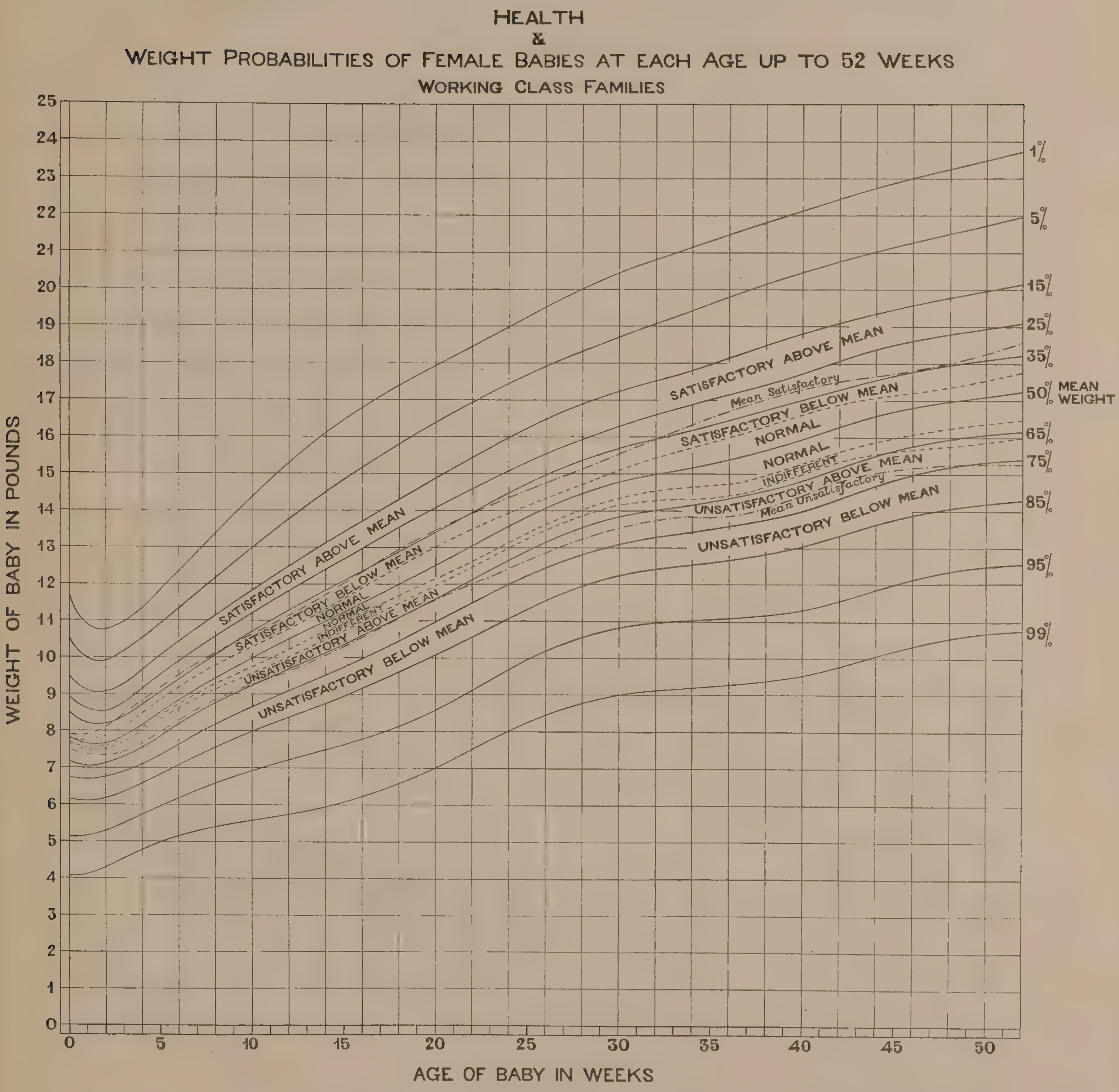


Diagram XLVIII.

class for each week of the first year. We show all our data, and the cubic curves. Points marked as 'hollow circles' were obtained by averaging weights over somewhat different periods. We believe that these are as satisfactory mean weight curves, or curves of baby's growth, as have hitherto been published.

Diagrams XLVII and XLVIII (pp. 120–121) give mean weight curves as found by contiguous arcs and not by cubic curves; the percentile weight curves are identical with those of the folding charts. The dotted health contours on these charts are very different from those on the folding charts. They were obtained in the following manner. From the correlation table of weight and health at a year formed for each age, the mean weight was determined, from the corresponding regression line, for the boundaries of each health category and for the means of some of the categories. These weights were plotted and the contour lines given as broken lines are the result after smoothing. Thus if a male baby of 24 weeks was 14 lbs., we could say that this was the average weight of male babies at that age, whose health as yearling babies was on the border line between normal and indifferent. What the chart really tells us is the probable weight at 24 weeks of a baby, who as a yearling bordered on indifferent health. This is really the inverse of our problem, it is the prediction of earlier weight from later health, whereas we want later health from earlier weight. Thus Diagrams XLVII and XLVIII while of interest do not provide a prognosis.

To reach this we start exactly as in Diagrams XLVII and XLVIII with our weight percentile curves, and having obtained these percentile contours we are able, for a baby of given age and weight, to state how many per cent. of babies of its category will exceed it in weight. We interpolate* between the contours and know the baby's grade—it is 3rd or 30th or 95th in a hundred babies of its age and social class.

We now turn to the true health contours. Contingency tables were formed of the health of yearling babies with the weights they had at, say, x weeks of life. In order to have adequate and fairly smooth material we actually clubbed five weeks of life and represented the result as the middle week x. Thus for week x we had a contingency table exhibiting four categories of health: *Satisfactory* (I and II), *Normal* (III), *Indifferent* (IV), and *Unsatisfactory* (V and VI); and each health category had an array of weights.

We took these categories of health on a normal scale, and if h be the health measured from the mean health and σ_h the unknown standard deviation of health, we were able to find the mean weight of the babies in any category of frequency n_h and so obtain a point to plot against the mean health $\tilde{h}$ of that category. The normal scale provided for each category is $\tilde{h}/\sigma_h$. If σ_w be the standard deviation of the weights of all babies in the sub-table and $\bar{w}$ their mean, the correlation of weight and yearling health is

$$r = S\left(\frac{n_h(\tilde{w}-\bar{w})\,\tilde{h}/\sigma_h}{N\sigma_w}\right),$$

where N is the total population of the sub-table, n_h the number of babies in the array of mean health $\tilde{h}$ and mean weight $\tilde{w}$, and S denotes sum for all arrays. The regression line of health on weight is:

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* This can often be done with adequacy by the eye, otherwise a rule of three sum must be furnished by a scale measurement.

$$\frac{\tilde{h}}{\sigma_h} = r\,\frac{w - \overline{w}}{\sigma_w},$$

and enables us for any age, i.e. given x, to predict the probable health $\tilde{h}/\sigma_h$ on a normal scale corresponding to a given weight w.

In order to get health contours we had to ask what weight w at each age would give a definite health grade as the probable health of the baby. In other words, we put

$$w = \overline{w} + \frac{\sigma_w}{r}\,\frac{\tilde{h}}{\sigma_x} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (E),$$

and made $\tilde{h}/\sigma_x$ correspond to 1 °/o, 5 °/o, 15 °/o, 25 °/o, 35 °/o, 45 °/o, 50 °/o, 55 °/o, 65 °/o, 75 °/o, 85 °/o, 95 °/o, 99 °/o of babies healthier on the normal scale of health*. It became at once obvious that weight being only very moderately correlated with health, it is necessary that babies should have extremely high weights or extremely low weights in order that we can predict, from weight only, the highest and lowest grades of health. Such weights are extremely rare, if not impossible, and it is quite certain that if babies occurred of such weights it would be dogmatic in the extreme to suggest that our linear regressions held up to such weights. They are only in part drawn in to complete the diagrams, but their chief interest is to indicate how little evidence weight in new-born babies, or in babies in the early weeks of life, provides of what their health as yearling babies will be.

The following tables give the correlations between weight and health at the ages in weeks of the first column, and also the 'inverted regression line' (E) from which the w for each grade of probable health was determined:

TABLE CXLI. *Correlations of Weight and Health.*

Boys			Girls		
Weeks	Correlation	Inverted Regression Line	Weeks	Correlation	Inverted Regression Line
0·0	·1806	$w = 7{\cdot}9162 + 11{\cdot}2239\tilde{h}/\sigma_h$	0·0	·0856	$w = 7{\cdot}6203 + 19{\cdot}8405\tilde{h}/\sigma_h$
0·50	·2184	$w = 7{\cdot}5842 + 9{\cdot}3535\tilde{h}/\sigma_h$	0·76	·1601	$w = 7{\cdot}6891 + 10{\cdot}2217\tilde{h}/\sigma_h$
1·86	·4804	$w = 6{\cdot}6831 + 3{\cdot}7396\tilde{h}/\sigma_h$	1·95	·3017	$w = 7{\cdot}6117 + 4{\cdot}8421\tilde{h}/\sigma_h$
2·80	·3948	$w = 8{\cdot}1523 + 4{\cdot}3640\tilde{h}/\sigma_h$	2·86	·2624	$w = 7{\cdot}9251 + 5{\cdot}9245\tilde{h}/\sigma_h$
7·25	·3282	$w = 9{\cdot}6375 + 6{\cdot}2353\tilde{h}/\sigma_h$	7·14	·2869	$w = 9{\cdot}2609 + 5{\cdot}9699\tilde{h}/\sigma_h$
12	·3247	$w = 11{\cdot}0837 + 7{\cdot}7608\tilde{h}/\sigma_h$	12	·2917	$w = 10{\cdot}3331 + 7{\cdot}4127\tilde{h}/\sigma_h$
17	·3448	$w = 12{\cdot}4831 + 7{\cdot}8897\tilde{h}/\sigma_h$	17	·2989	$w = 11{\cdot}7182 + 7{\cdot}9567\tilde{h}/\sigma_h$
22	·2682	$w = 13{\cdot}8375 + 10{\cdot}8934\tilde{h}/\sigma_h$	22	·3145	$w = 12{\cdot}9918 + 7{\cdot}6370\tilde{h}/\sigma_h$
27	·3509	$w = 15{\cdot}0359 + 8{\cdot}7813\tilde{h}/\sigma_h$	27	·2551	$w = 14{\cdot}1350 + 9{\cdot}7542\tilde{h}/\sigma_h$
32	·3459	$w = 15{\cdot}9897 + 8{\cdot}6172\tilde{h}/\sigma_h$	32	·3154	$w = 14{\cdot}9989 + 8{\cdot}0374\tilde{h}/\sigma_h$
37	·3391	$w = 16{\cdot}8293 + 9{\cdot}1012\tilde{h}/\sigma_h$	37	·3952	$w = 15{\cdot}4688 + 7{\cdot}0012\tilde{h}/\sigma_h$
42	·3836	$w = 17{\cdot}6874 + 7{\cdot}8620\tilde{h}/\sigma_h$	42	·3544	$w = 16{\cdot}2366 + 8{\cdot}1158\tilde{h}/\sigma_h$
47	·4275	$w = 18{\cdot}1273 + 7{\cdot}2786\tilde{h}/\sigma_h$	47	·3664	$w = 16{\cdot}7349 + 7{\cdot}2571\tilde{h}/\sigma_h$
52	·4126	$w = 18{\cdot}8033 + 7{\cdot}2864\tilde{h}/\sigma_h$	52	·4769	$w = 17{\cdot}0640 + 5{\cdot}7572\tilde{h}/\sigma_h$

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* The corresponding values of $\tilde{h}/\sigma_h$ are 2·3263, 1·6449, 1·0364, ·6745, ·3853, ·1257, ·0000, $-$·1257, $-$·3853, $-$·6745, $-$1·0364, $-$1·6449, $-$2·3263 respectively.

The expressions for $\overline{w}$, i.e. the constants on the right-hand side of the inverted regression lines, have already been smoothed. The correlations were not smoothed, but only the values of σ_w/r which form the factors of $\tilde{h}/\sigma_h$ in the inverted regression lines. We were fairly certain of exaggerated values here owing to the paucity of data, which has led to considerable irregularities not only in the values of r, but of σ_w, and these are peculiarly emphasised in the neighbourhood of birth. But there is no doubt that there is the same dip in the health contours in the early weeks of life that we find in the weight contours; and there is also no doubt that the correlation of weight and yearling health is least at birth. It may be hoped that the publication of this memoir will lead to the collection of wider data for the weights of babies in the first month of life and the health of the same babies at a year.

The following remarks indicate the character of the charts:

Method of Use. Enter the chart by the vertical line corresponding to the weeks of age of the given baby and by the horizontal line corresponding to the weight of the baby at that age. The point where the horizontal and vertical meet denotes the relative position of this particular baby on the chart. Judge the relative distance between the baby's position and the two adjacent *continuous* line curves; this will give the percentage of babies who are heavier than the given baby. Next determine the relative distance between the baby's position and the two adjacent broken line curves, this will give the *probable* percentage of babies healthier than the given baby when it shall have completed its first year. It is a forecast of the baby's future health. These percentage-health-curves include those babies who, alive at the given age with a given weight, yet do not survive to be a year old. Any baby whose weight at a given age places it below the 75 °/ₒ health line at the end of the year certainly needs special treatment.

The charts will be found useful for plotting the weights at successive ages of any individual baby. It will be seen at once whether that baby is maintaining or improving its grade of weight and health.

Illustrations. (i) A male baby 30 weeks old weighs 21½ lbs. Only 2 °/ₒ to 3 °/ₒ of babies at that age are heavier than this baby, i.e. it is a "two in a hundred" baby. Judging from the weight and weight alone it is improbable that more than 26 °/ₒ of babies will be found healthier than this baby when it comes to be a year old.

Such is the prognosis as far as weight can tell us of future health.

(ii) A female baby is only 10 lbs. at the end of 36 weeks. About 97 °/ₒ of female babies at 36 weeks are heavier than this one; its grade is therefore very bad. At the end of the year 74°/ₒ of babies will probably be healthier than this baby will be. It needs therefore great care.

10. GENERAL CONCLUSIONS.

Although the present material covers some 20,000 weighings of babies, it represents rather sparse material when we come to break it up into weeks of age for either sex. In many cases the requisite information fails, when we come to correlate the effect, say, of environmental conditions with health or weight at a given age. It is hard to impress upon district visitors and others concerned with the immediate welfare of the baby how important it may be for the welfare of the future generations of babies to fill in, and fill in accurately, the facts, apparently of no immediate values, which are asked for in the *questionnaire*. The value of well-filled in *questionnaires* can be in part realised from the present memoir. We have probably one of the largest baby welcome schemes in the country most generously placing its material at our disposal, and we are still compelled to complain of inadequate data.

The returns are as good as, if not better than, those of most voluntary welcome systems, but the essential need of full information has not been fully realised. In particular there is no adequate information as to the habits of both parents. Again, the wage of the father, or better the family income, has not been as fully dealt with as desirable. For many babies there exists no record of either income or father's wage.

We admit the difficulty of precise information on this point; we do not speak without having experienced the difficulty in our own laboratory inquiries, but we do know inquiries where the information has been more satisfactory than it is in the present case. Probably a good deal of information could be reached by judicious inquiries from local charities and charity organisations, from the police, from school dinner rolls and rent-collecting agents. Anyhow we shall not solve many of the problems connected with baby's welfare and environment until we have better data for the economic position of the family.

Notwithstanding this deficiency of material there are, we still think, many points of interest in the reduction of our data. Among these we may note the following:

(*a*) Clothing is not highly correlated with Baby's Health. The least advantageous clothing appears not to be cotton, but mixtures of flannel and cotton, or mixtures of flannel and wool.

(*b*) It is not the economic condition, as measured by Father's Wages, but rather the Habits of the Mother, as measured by the orderliness of the home, which determines the character of the Baby's Clothing.

(*c*) Parental Health is not the source of want of orderliness in the home, or of the type of clothing.

(*d*) The correlation of Clothing and Health of Baby weakens as the baby grows older.

(*e*) The influence of Breast-feeding on Baby's Health is not so important as is generally asserted; it is largely a secondary result of artificial feeding being associated with poor health in the mother. As the Mother's Health passes from strong to weak, so the months of Breast-feeding decrease.

(*f*) We found no association of Home Conditions with the extent of Artificial feeding.

(*g*) The nature of the feeding has small influence on the weight of boys; it has considerably more in the case of girls, and the association of girls' weight with feeding is greater than that of girls' health with feeding. This appears to be part of what may possibly be a general principle that girls respond more to environment—generally maternal environment—than boys do.

(*h*) The nature of feeding is not a more important factor of Baby's Health than its Clothing or its Home Conditions.

(*i*) The correlations of Mother's Health before pregnancy, during pregnancy and after confinement are considerable. But Mother's Health during pregnancy is less closely associated with extent of Breast-feeding than her Health before pregnancy or after confinement.

(*j*) The period of Breast-feeding depends on the Age of Mother, being short when she is young, increasing to a maximum at 29·88 years and then falling again. This physiological change in suckling capacity she shares with other living forms.

(*k*) There is a small but insignificant correlation between Mother's Health and Weight of Baby; but while mothers in poor health have babies with the least weight, the strongest mothers do not appear to have babies of greatest weight.

(*l*) There appears to be no marked correlation between the Cleanliness and Health of Baby, nor is the Cleanliness of Baby associated with the Health of its Mother. It is very substantially correlated, however, with the Orderliness of the Home.

(*m*) There is a definite correlation (·37 to ·43) between Baby's Health at birth and at a year.

If, as we have seen stated, "all babies are born healthy," no such correlation should exist. The statement is probably based on mistaking the newness of the machine for fitness for working well; the actual value of the new organism can hardly be settled until it has had time to test the physiological strength of its organs against their new environment.

(*n*) Cleanliness of Home has a significant but small association with baby's Health and Weight. It is conceivable that this is only an indirect effect, both being related to the Habits of Mother.

(*o*) Crowding depends largely on the Number of Living Children, with which it is highly correlated.

Housing cannot be gradually expanded as the number of children increases. There appears to be one step, from a 3—4 roomed tenement to a 4—5 roomed tenement, and this seems made, if made at all, about the time when the eldest children begin to earn money.

Crowding is related to Father's Wages, but on the average as the wages rise from zero to 50*s*. a week there is only 0·5 person additional per room.

(*p*) There is no fitting correspondence between Wages and Size of Family, i.e. as the latter increases Wages do not increase in proportion; in fact, men with the higher wages have the fewer children.

Rent increases with Wages, but the maximum increase, 1*s*. to 1*s*. 6*d*. per week, is not adequate to provide the increased accommodation requisite as a family increases from three to ten members, even if Wages increased proportionately to Size of Family.

(*q*) There is an insignificant correlation between Number of People per Room and Health of Mother; a significant but small correlation between Crowding and Father's Health. We cannot interpret this as denoting that the mother grows immune to crowding, and the father working out does not—as it has recently been suggested; we believe it to be due to the fact that fathers in bad health have low wages, and crowding is correlated with low wages.

(*r*) There is a significant, but very small, correlation between Health of Yearling Babies and Crowding. We believe it may be accounted for by the fact that later pregnancy babies are less strong, and the later the pregnancy the larger the family and the more crowding.

(*s*) There is a considerable correlation between Father's Health and Father's Wages; between the latter and Health of Wife there is an insignificant correlation. This supports the interpretation that on the average the man gets low wages because he has not physical strength; otherwise the bad economic condition should affect the health of wife as well as of husband. It seems probable that the slight correlation between Baby's Health and Father's Wages is a reflex of the health of the father and not a result of economic conditions.

(*t*) There is a quite sensible but small correlation between Health of Husband and Health of Wife; it appears not to be due to common economic conditions, but to assortative mating, the physically feeble man fails to obtain on the average a strong wife.

(*u*) We consider Rent a far better measure of economic prosperity than Father's Wages. The correlations of Baby's Health and Rent are if significant of small importance; but the correlations of Baby's Weight and Rent are of greater intensity (·15 for boys and ·38 for girls). If we correlate Baby's Health with Rent for constant Weight the association is zero for boys and even negative for girls. Thus rent does not appear to directly affect health, but only indirectly so far as weight is a sign of health. Thus it would appear that better economic conditions may give a heavier baby, but this does not necessarily mean a healthier baby.

(*v*) Mother's Employment is related to the Size of her Family, but on investigation the bulk of this relationship is seen to be due to the fact that her age is correlated with Employment. Her Employment is correlated with Father's Wages and Father's Health, but not very highly. Mother's Health is also associated with her Employment, but while home and factory mothers have practically equal health, it is the charing mothers who appear to have worse health and are of a rather feebler inferior class. The association is, however, hardly significant.

(*w*) Mother's Health decreases with the Number of her Children, but only very slightly. This appears to be the result of her health decreasing, again very slightly, with her age. In fact, for constant age the larger her family the stronger she appears to be. There is no evidence in the class we are dealing with of grave detriment to the woman arising from a large family.

(*x*) Generally the employment of the mother is not a seriously harmful factor in infant welfare; indeed, mothers in indifferent and poor health seem to do better for their children if they work out.

(*y*) When we turn to the influence of Mother's Employment on Weight of Baby we find it is of no significance in the case of boys and significant, but small, in the case of girls. On the other hand, the outworkers are the younger (factory) and older (charing) women, and Mother's Age is related to Weight of Baby. We need ampler data to analyse effectively these small associations.

(*z*) About 71 °/ₒ of babies use no cradle and sleep with their parents. The correlation between health of baby and sleeping alone is very slight, and may well be due to the fact that the more delicate babies more frequently sleep better if sharing the mother's warmth.

(*aa*) The detrimental effect of the Baby Pacifier has been largely exaggerated. There is a quite sensible correlation between the Health of yearling Babies and the Use of the Comforter, but this correlation is nearly doubled when we take the health of babies under fourteen days of age, and the use of the comforter, i.e. the use of the comforter in later infant life! The Use of the Comforter is also significantly correlated with Health of Mother. In other words, it is the delicate babies and babies with mothers in poor health who are provided with comforters, and naturally the use of the comforter is associated with poor health in the baby.

(*bb*) There is a very slight correlation between the Order of the Pregnancy and Health of the Baby, and this is probably the source of the number of other children slightly affecting baby's health.

(*cc*) The influence of parental healths on health of baby is not a straightforward problem, because we are associating infantile and adult healths. Still the correlations of the parental adult and the offspring's infantile health are of a higher order than most of the correlations we have so far considered (Father's ·18 to ·20, Mother's ·23 to ·24).

(*dd*) A study of the relations to Baby's Health of Mother's Health before pregnancy, during pregnancy and after confinement indicates that the first is the most important, and suggests that we are dealing with a true hereditary-factor, which would be more marked could we associate parents' and infants' healths at the same ages.

Mother's Health before pregnancy is less closely related to Baby's Weight than to Baby's Health.

(*ee*) The correlation of Baby's Weight with Baby's Health has probably been usually exaggerated. It is of the order ·4.

(*ff*) As the influence of weight at a given age on future progress of the infant seems to be the desideratum we have provided charts giving (i) the probable health of the yearling baby from a knowledge of its weight at any earlier age, and (ii) the grade of a baby of given weight at a given age, i.e. the position it takes in the general population of babies of that age. While these charts may serve as useful indications, they should be interpreted with due allowance for the fact that they are not based on the population at large, but on the babies of the rather poorer paid working classes in a large North of England manufacturing town.

(*gg*) While our conclusions in this memoir have in the main been drawn by the methods of the correlational calculus, we have provided a long series of diagrams, which may help the uninitiated reader. These diagrams must, however, be interpreted with some caution because (*a*) they do not carry on the face of them the limitations of the material enforced by consideration of probable errors, and also (*b*) we have been obliged to use approximate methods, such as the assumption of normal arrays, to obtain graphs at all. Still they do in a broad and general way indicate the trend and relationship of the various factors we have been discussing, and they will, if not over emphasised, be of considerable service.

In conclusion, we have to thank Miss Ida McLearn for the strenuous labour she has put into our diagrams and for the patience she has exhibited when, as our ideas developed, it became necessary to redraw entirely or at least largely to modify several of them.

We have also to thank Miss Ethel M. Elderton for much help and suggestion from the much wider material she has in hand on kindred topics, the extent of which has alone hindered its appearance before this slighter study. It is sufficient here to say that while there may be divergencies between some of our conclusions and hers, and between some of our methods and hers, she reaches the fundamental principle that it is the healths and habits of the two parents far more than the environmental conditions upon which the welfare of the infant depends.

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